

Combined Sewer Overflow Control Program

**CSO Control
Program Review**

April 2006



King County

Department of
Natural Resources and Parks

Wastewater Treatment Division

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2005 CSO Control Program Review

April 2006



King County

Department of Natural Resources and Parks

**Wastewater Treatment Division
Combined Sewer Overflow Program**

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Executive Summary

In adopting the Regional Wastewater Services Plan (RWSP) in 1999, the Metropolitan King County Council recognized that the RWSP was a complex and dynamic plan that would require regular review and updates. The Council specifically called for a review of the benefits of the combined sewer overflow (CSO) control program, an essential component of the RWSP.

The Wastewater Treatment Division (WTD) of the Department of Natural Resources and Parks completed the CSO control program review over the last several years. The results of the review indicate that the program, as detailed in the RWSP, continues to be a sound program to control all of the County's CSOs by 2030. WTD recognized the value of this review and will conduct similar reviews on a regular basis ahead of CSO control plan updates. The next review will occur in 2010.

Accomplishments of the CSO Control Program

Years ago, the common wastewater management practice was to provide a single sewer pipe to carry both wastewater and stormwater. Such pipes were called "combined sewers." Until the early 1940s, nearly all sewers constructed in the City of Seattle were combined sewers that simply carried waste to the nearest body of water without treatment. Treatment plants were slowly added to the system. During large storms, combined sewers may collect more stormwater than the pipes and treatment plants can handle. Combined sewer overflow (CSO) outfalls act as relief points for this excess flow to protect treatment plants from huge influxes of water and to prevent wastewater from backing up into streets and basements. The City of Seattle owns about 100 and King County owns 38 CSO outfalls.

Although they are highly diluted, CSOs release potentially harmful bacteria and pollutants, may cause aesthetic degradation, and may reduce sediment quality near the discharge sites. Regulations, agreements, policies, and public perceptions require, either directly or indirectly, the reduction of CSOs to protect water quality, sediment quality, and aquatic species in our water bodies. The Washington State Department of Ecology (Ecology) requires agencies to "control" CSOs so that an average of no more than one untreated discharge occurs per year at each CSO site. The most recent CSO control plan, prepared as a part of the RWSP and updated in 2000, calls for control of all King County CSOs by 2030.

The WTD CSO control program implements the CSO control plan. The program employs various ways to control CSOs, including controlling pollution at its sources, optimizing flow management, monitoring and modeling flows in the system, and constructing CSO control facilities.

Projects to control CSOs in the region began in the late 1970s. So far, about \$320 million has been spent to control CSOs and another \$383 million is planned to implement the CSO control projects in the RWSP. In 2005, two major facilities were finished: the Mercer/Elliott West system, completed at a cost about \$140 million, and the Henderson/Norfolk system, completed at a cost of \$77 million. Both systems include a large storage/treatment tunnel and additional treatment facilities.

Since 1988, when routine monitoring of CSO flows began, the CSO control program has resulted in significant progress. CSO volumes have been reduced by nearly 60 percent, from an estimated 2.4 billion to approximately 900 million gallons per year. The County is committed to completing this work by 2030. A graph of progress since 1988 and expected progress through 2030 is shown in Figure ES-1.

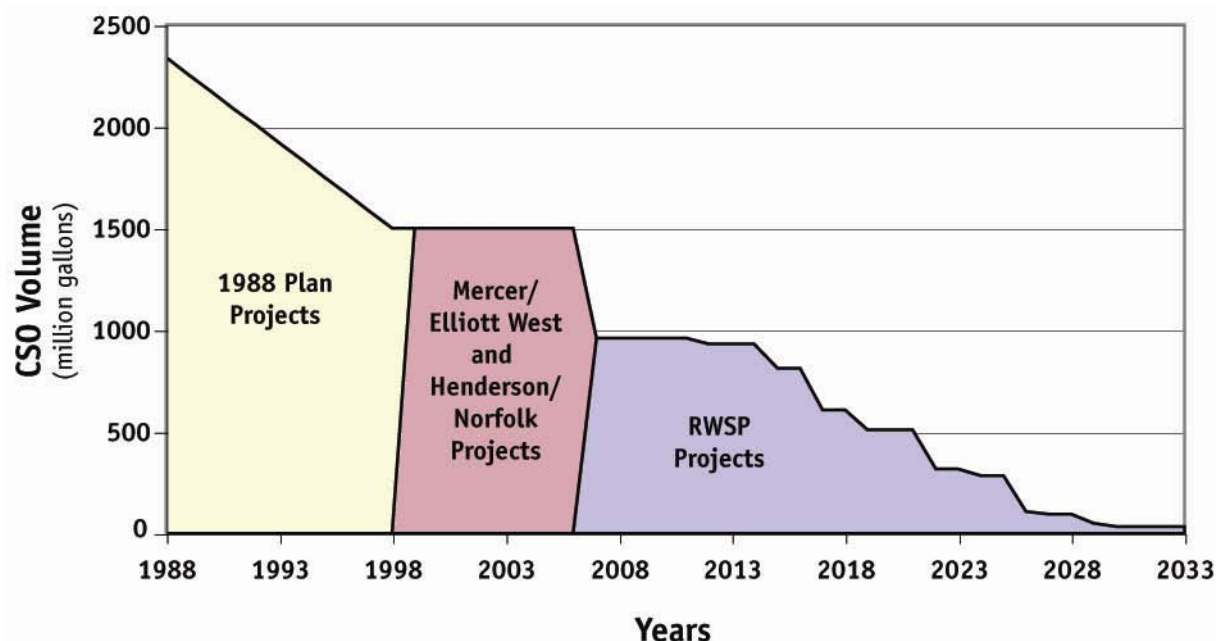


Figure ES-1. CSO Reduction Since 1988

Highlights of the CSO Control Program Review

To conduct the CSO control program review, King County staff have gathered and assessed information generated since adoption of the RWSP. The review has identified areas of efficiency and success, as well as areas where improvements to the program could be made. These improvements are being implemented.

This CSO program review reaffirms the RWSP priorities of protecting public health, the environment, and endangered species that shaped the development of the CSO control program. It also has reinforced WTD's practice of transferring as many CSO flows as possible to regional plants for best available treatment. In keeping with the RWSP schedule, predesign will begin in mid 2006 on projects with the greatest benefit to human health protection—the Puget Sound

Beach projects. These projects are storage or conveyance projects that will transfer flows to the West Point plant. State Revolving Fund loans will help to pay for preparation of facility plans for three of these projects.

This review revealed upward cost pressures on the CSO control program. Changes in the market and regulatory guidance may require further exploration of alternative CSO treatment technologies and subsequent changes to design of CSO control facilities. New technologies that offer some promise for greater cost-effectiveness will be piloted between 2006 and 2009.

As a result of the review, the hydraulic model used to predict the effectiveness of CSO control and to design CSO control projects is being updated and recalibrated. The updated model is expected to be ready in 2007. When the model is updated, projects may be resized, cost-effective technology changes may be incorporated, and new cost estimates will be developed.

The remainder of this section summarizes the review process, its conclusions, and any remaining issues. It is organized according to the topics listed in the RWSP for the CSO control program review:

- Maximizing the use of existing CSO control facilities
- Identifying the public and environmental health benefits of continuing the CSO control program
- Ensuring that projects are in compliance with new regulatory requirements and objectives such as the Endangered Species Act and the Wastewater Habitat Conservation Plan
- Analyzing rate impacts
- Ensuring the program review will honor and be consistent with long-standing commitments
- Assessing public opinion
- Integrating the CSO control program with other water and sediment quality improvement programs for the region

Maximizing the Use of Existing CSO Control Facilities

As a part of the CSO program review, WTD inventoried its existing practices that relate to CSO control. In addition, each CSO facility and rain gauge was physically inspected and monitoring data were reviewed to assess the status of CSO control. Improvements were made based on these inspections and review. The scope was then broadened to include employee input on ways to enhance control program organization, coordination, and communication.

This review highlighted WTD's practice to ensure that combined sewage receives the best treatment possible by sending as much flow as possible to regional plants. CSO control facilities, such as storage or satellite treatment facilities, are built to manage peak flows that occur between 1 and 30 times per year. As such, they operate as backup to the transfer of flows to regional treatment plants—operating only when flows cannot be immediately conveyed to these plants.

These facilities will be used infrequently to achieve the regulatory control standard and provide optimum treatment to all flows.

Identifying the Public and Environmental Health Benefits of Continuing the CSO Control Program

During this program review, WTD took a fresh look at existing information, reviewed new information, and completed studies to assess—both quantitatively and qualitatively—the health benefits to the public, environment, and endangered species of bringing all CSOs under control. The assessment drew from studies describing existing environmental conditions and predicted conditions at the completion of the program. It built on the findings of the County’s 1998 *Water Quality Assessment of the Duwamish River and Elliott Bay* (WQA) and 1999 *Sediment Management Plan*—both done in support of the RWSP—and on subsequent annual RWSP water quality reports.

Knowledge from recent scientific studies does not warrant any change in course. The primary benefit from the CSO control program remains the reduction in public health risk from pathogens—bacteria and viruses—found in CSOs. People enjoying our waterways—experiencing the power of storm-driven waves, prime windsurfing, and diving during the best winter months—will be more confident about the quality and safety of these recreational activities.

Many recent studies have focused on the Duwamish River because of sediment cleanup projects in the area. With regard to protection of human health, information generated from the Lower Duwamish Waterway Superfund process is increasing our understanding of fish consumption and human health risk. Studies under way may shed more light on whether these risks result from historical sediment contamination or from an ongoing contribution from CSOs and other sources. If an ongoing human health risk from CSOs in the Duwamish River is identified, King County may consider changes in the control schedule to accelerate the CSO control projects in these locations. Determining relative priorities will be difficult because comparable information is not as available for other areas where CSOs occur, such as Elliott Bay, the Ship Canal, and the East and West Waterways of the Duwamish River.

With regard to protection of salmon, the perception that CSOs are harmful must consider that the area with the greatest volume of overflow—the Duwamish River—has the healthiest run in terms of numbers of both hatchery and naturally spawning fish. At this time, protection of endangered salmon does not appear to be enhanced by changes in the CSO control schedule that would prioritize the Duwamish River over other locations.

Ensuring that Projects Are in Compliance with New Regulatory Requirements and Objectives Such as the Endangered Species Act and the Wastewater Habitat Conservation Plan

King County has a strong history of compliance with regulations regarding its CSO discharges—both treated and untreated. The County also responds quickly to changes in regulations and even works to anticipate these changes. For example, WTD’s support of the watershed planning process and the studies for the Habitat Conservation Plan will ensure that the CSO control plan and projects meet the objectives of the Endangered Species Act.

WTD’s CSO treatment facilities meet the regulatory limits for their discharges with few exceptions. The CSO control plan laid out in the RWSP was devised to ensure that the County continues to make steady progress in meeting Ecology’s CSO control standard of an average of one untreated CSO discharge per year at each CSO location by 2030.

The design of CSO control facilities must consider not only current regulatory requirements but also possible changes in the requirements in the next 5 to 10 years. Even with this ongoing vigilance, unexpected changes in regulations and methodologies to implement the regulations can occur that may affect program planning and implementation. For example, between the planning phase and the permitting of the new Mercer/Elliott West and Henderson/Norfolk CSO storage and treatment facilities, Ecology changed the methods to identify the need for and define effluent permit limits. WTD will monitor these facilities for their compliance with these permit limits and will include the new methods in planning for future projects. In addition, promising treatment technologies will be evaluated for their ability to meet possible future requirements in pilot projects proposed for 2006–2009.

Analyzing Rate Impacts

The RWSP CSO control program recommended that 21 projects be built between 2005 and 2030. The total project constant capital cost for these projects was estimated to be \$311 million in 1998. In 2005 dollars, the projects are estimated to cost \$383 million.¹ The project schedule for the RWSP CSO control program was designed to spread costs over time and to support a stable sewer rate. The current RWSP program without recommended refinements and updated estimating will contribute \$0.27 per month to rates in 2010, \$2.45 in 2020, and \$4.65 in 2030.²

Cost estimating involves a narrowing process so as to limit resources and time spent on alternatives that will be discarded. The accuracy of cost estimates increases as projects become more defined and are specified in greater detail. Planning-level cost estimates, such as those used

¹ In addition to accounting for 3 percent per year inflation, this total reflects the deletion of the SW Alaska Street CSO project and the addition of CSO plan updates and sediment management activities that were mandated but not funded in the RWSP. (Monitoring and analysis indicate that the CSO at SW Alaska Street is controlled.) See Appendix C for a table that summarizes current RWSP project costs.

² These rates include 3 percent inflation per year, starting from 2005 dollars. The rates without inflation would be \$0.23, \$1.63, and \$2.22 for the same years.

in the RWSP, are based on generic facility concepts. Specific details of the project such as location, technologies, and environmental impacts are determined later during project predesign.

No detailed analysis of CSO project costs has been done since the RWSP because an update of the hydraulic model—recommended by this review and currently under way—will likely change sizes, definitions, and thus costs of several planned control projects. However, similar to increased estimates seen for the original RWSP “North Plant” (Brightwater) and conveyance program, increased estimates for CSO control projects can be expected. WTD has begun two activities that have the potential to offset the cost increases that appear could result from changes in market conditions and estimating methods:

- The hydraulic model is being updated and calibrated so that it can more accurately update and refine project sizing.
- Pilot tests will be conducted on promising new CSO treatment technologies that may reduce facility footprint and cost.

These activities are expected to produce new project definitions and improved cost estimates for a next CSO control plan review in 2010.

Ensuring the Program Will Honor and Be Consistent With Long-Standing Commitments

The CSO control plan represents a responsible approach to controlling CSOs on behalf of the 34 local agencies that contract with King County for wastewater conveyance and treatment. The plan takes into account commitments made to these agencies and to communities and regulatory agencies through agreements and other mechanisms.

WTD continues its commitment made to the public and Ecology to make steady progress toward control of all of its CSOs by 2030. Scheduling flexibility is maintained within that timeframe to take advantage of concurrent or joint project opportunities or to respond to changing needs. In keeping with RWSP policy commitments, the plan will be modified, when needed, to respond to emerging developments in science and technology.

Assessing Public Opinion

WTD’s ongoing public involvement program informs and engages the public and local agencies in planning, design, and operating decisions that affect them. Public involvement activities helped to shape the RWSP, including its CSO control element.

The 1998 CSO water quality assessment was conducted with valuable input from regional stakeholders. This stakeholder process, along with other public opinion surveys conducted during formulation of the RWSP, indicated that water quality is a priority to the citizens of King County, that the County has a mandate to protect and enhance water quality, and that the citizens believe CSOs should be controlled. In one survey done for the RWSP, 75 percent of the respondents said that CSOs should be prevented even if it increases sewer rates.

The County has continued to assess public opinion through annual surveys and community involvement work on other wastewater projects. The message heard during RWSP formation has been continually reaffirmed through all WTD public involvement activities since the RWSP was adopted. In its recent annual water quality survey, King County repeated the same questions asked in 1997 and heard similar results: 79 percent of respondents said that the County should prevent CSOs into Puget Sound, rivers, and lakes during storms, even if it increases sewer rates; only 4 percent believed controlling CSOs was not worth such investments.

The messages heard to date, information resulting from this program review, and any new public opinion heard during the plan updating process will shape the program to be in keeping with the expectations of our citizens.

Integrating the CSO Control Program with Other Water and Sediment Quality Improvement Programs for the Region

To save costs, improve efficiencies, and reduce redundancies, the CSO control program integrates its work with both internal and external programs aimed at improving water and sediment quality in the region.

The CSO control program makes every effort to coordinate CSO control projects with wastewater system upgrade and refurbishment projects to optimize designs, share mutual project costs, and minimize community disruption. For example, upgrades to the Barton Pump Station were expanded to the maximum capacity that the station can accept in order to minimize the size of the anticipated CSO control project. Likewise, emergency repairs of the Barton force main and Ballard siphon have considered CSO control plans to the extent possible without delaying the repairs. The siphon repair may control CSOs at the Ballard location without the need for a later control project.

WTD and the City of Seattle are consulting on ways to coordinate CSO control projects in overlapping areas and to handle the addition of more City CSO flows into the County conveyance and treatment system. The RWSP defined the Ballard CSO control project as a joint project with the City. Now that the need for the Ballard project may be eliminated, WTD has offered the City the opportunity to contribute incremental costs to provide capacity in the siphon for the City's Ballard CSOs. If the City wishes to explore this opportunity further, the implications for siphon sizing, buildability, and West Point capacity will be assessed. Other projects that will be evaluated include the City's Windermere and the County's University Regulator projects, as well as a possible joint storage project in the Madison Valley and Montlake areas. These and any other opportunities for coordination will be considered in the 2008 update to the CSO control plan.

Next Steps

When the hydraulic model is updated, projects will be resized, any necessary technology changes will be incorporated, and new cost estimates will then be developed. Some of this information, including any recommended schedule changes to address new scientific information, may not be

available for the next plan update due to Ecology in 2008; all the information should be available for public discussion ahead of the next CSO control program review in 2010—and well ahead of commitments to Ecology for the CSO plan update that follows the review.

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Chapter 1

Introduction

This report documents King County's review of its combined sewer overflow (CSO) control program conducted in accordance with policies and guidelines in the 1999 Regional Wastewater Services Plan. The first three chapters provide background information on planning and implementation of CSO control. Chapter 4 discusses the results of the program review and describes other factors that influence CSO control planning. Finally, Chapter 5 describes the activities that will follow the review, including implementation of the next CSO control projects.

The remainder of this chapter gives an overview of the purpose of the review and describes the nature and locations of CSOs in King County, the reasons for controlling CSOs, and the County's CSO control strategies.

1.1 Why Conduct a Program Review?

In 1993, work began on the Regional Wastewater Services Plan (RWSP), a revision to the 1958 comprehensive sewer plan for the wastewater service area in King County. Adopted in 1999, the plan sets out to integrate long-range planning in all areas of wastewater services and to establish priorities for all wastewater programs. One component of the RWSP is a CSO control plan that describes King County's program and schedule to reduce CSOs. King County implements the CSO control plan through the Wastewater Treatment Division's CSO control program.

The CSO control plan in the RWSP was updated in 2000 and submitted to the Washington State Department of Ecology (Ecology) in conjunction with renewal of the NPDES permit for the West Point Treatment Plant. No changes to the CSO control plan were recommended under the 2000 plan update, mainly because the permit renewal application was due only 6 months after adoption of the RWSP.

In adopting policies for the RWSP, the King County Council recognized that much can change in 5 years. Science and technology are continually evolving. This new knowledge, as well as changes in conditions and costs, must be considered in planning for CSO control. To this end, RWSP policy requires that the benefits of completion of the CSO program be reviewed before finalizing commitments under the NPDES permit. This CSO program review has been completed for Council consideration and input. Findings will be incorporated into the CSO plan update that will be submitted to Ecology in 2008 as part of the next NPDES renewal.¹

¹ NPDES (National Pollutant Discharge Elimination System) permits are defined later in this chapter. These permits are usually renewed every 5 years. The CSO plan update that was expected to be due in 2005 will now be submitted in 2008 because of a delay in Ecology's NPDES permit renewal schedule.

1.2 What Are CSOs?

CSOs are untreated wastewater and stormwater that discharge directly from CSO outfall pipes into marine waters, lakes, and rivers during heavy rainstorms when sewers are full.

There are two types of sewer systems in the King County wastewater service area: separated and combined (Figure 1-1). In separated systems, sanitary sewers carry untreated wastewater to a treatment plant and storm sewers carry stormwater from rooftops, driveways, sidewalks, streets, and other impervious surfaces to the nearest water body. Separated systems are now considered standard engineering practice, but this was not always the case. A hundred years ago, the common practice was to provide a single sewer pipe to carry both wastewater and stormwater. Until the early 1940s, nearly all sewers constructed in Seattle were combined sewers; separated sewers have been standard practice since about 1950. The City of Seattle is the only local wastewater agency served by King County that has a combined sewer system.

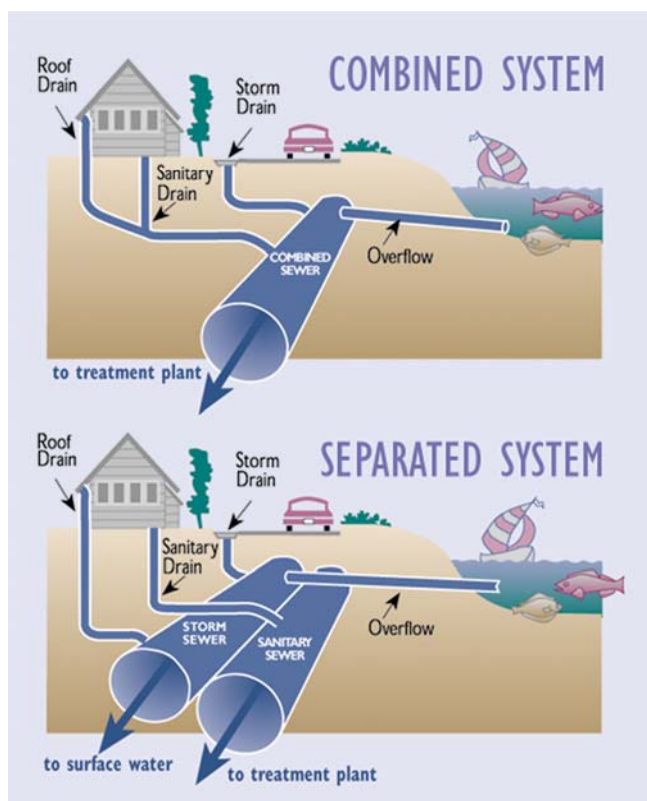


Figure 1-1. Combined and Separated Wastewater Conveyance Systems

In combined systems, wastewater and stormwater are carried through the same pipes. Wastewater flows in combined sewers are fairly constant, but stormwater flows fluctuate greatly depending on the amount of rainfall, its intensity, and the ability of the soil to absorb the rainfall. During large storms, the sewers may collect more stormwater than the pipes and treatment plants can handle. CSO outfalls act as relief points to protect treatment plants from huge influxes of water that could compromise treatment processes and also to prevent wastewater from backing up into streets and basements.

1.3 What Is King County's Role in Wastewater Management?

In 1958, the Municipality of Metropolitan Seattle (Metro) was formed to clean up the waters of Lake Washington and the Seattle waterfront. At the time, most wastewater in King County was transported from homes and businesses by sewers that discharged the untreated wastewater to the nearest water body. In the 1960s, Metro assumed ownership of the City of Seattle's wastewater treatment plants and portions of its sewer system and then built large pipes, called interceptors, to carry regional wastewater from local systems to the treatment plants.

In 1994, King County assumed Metro's responsibilities for regional wastewater management. Today, King County's Wastewater Treatment Division serves 34 cities and districts in and adjacent to King County. The County operates a "wholesale" business, providing wastewater conveyance and treatment services to "retailers" (local agencies), who in turn sell wastewater services to area residents and businesses.

King County's wastewater system is the largest in the Puget Sound region (Figure 1-2). The system includes two large regional treatment plants (the West Point plant in the City of Seattle and the South plant in the City of Renton), one small treatment plant on Vashon Island, one community septic system (Beulah Park and Cove on Vashon Island), four CSO treatment facilities (Alki, Carkeek, Mercer/Elliott West, and Henderson/Norfolk—all in the City of Seattle), over 335 miles of pipes, 19 regulator stations, 42 pump stations, and 38 CSO outfalls. The West Point, South, and Vashon plants provide secondary treatment; the CSO treatment facilities provide CSO treatment (the equivalent to primary treatment).² All seven treatment facilities discharge their treated and disinfected effluent to Puget Sound. Two new treatment plants are currently in design: the Brightwater regional plant, scheduled to start operating in 2010, and a smaller local treatment plant in the City of Carnation, scheduled to start operating in 2007.

The King County wastewater service area is divided into the East and West Sections. Separated wastewater from more than 122,000 acres that lie mostly east and south of Lake Washington is sent to the South Treatment Plant. The area west of Lake Washington sends a mixture of separated wastewater from north of Lake Washington and combined wastewater and stormwater flows from the City of Seattle to the West Point Treatment Plant. Approximately 41,000 acres of the 55,000 acres that comprise Seattle are served by combined or partially separated sewers. Once the new Brightwater plant is online, nearly all flow to West Point will be from the Seattle system.

The City of Seattle owns about 100 and King County owns 38 CSO outfalls (Figure 1-3). The two agencies communicate frequently and participate in each other's CSO planning efforts. Both

² In primary treatment, solids are removed from the wastewater, usually by allowing them to settle to the bottom of large tanks. The wastewater is then disinfected, usually with chlorine, and discharged. Secondary treatment includes primary treatment, followed by a biological process to break down organic material, more solids settling, and then disinfection and discharge.

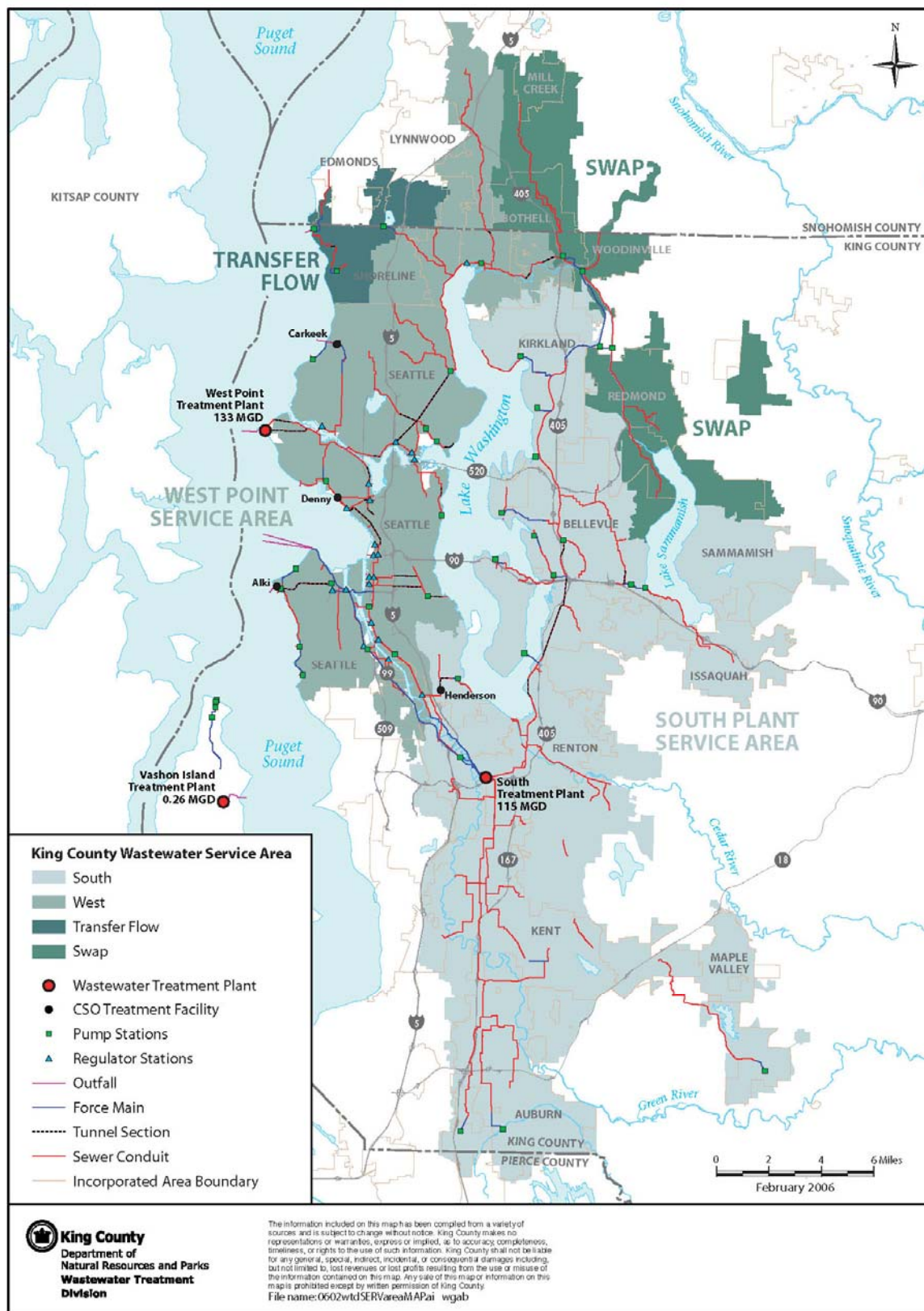


Figure 1-2. King County Wastewater Service Area and System



Figure 1-3. King County and City of Seattle Combined Sewer Overflow Locations

agencies pursue joint CSO control projects if the projects are deemed to be cost-effective for ratepayers or if they minimize disruption to nearby communities.

To prevent duplication and conflicts, the County and City also coordinate their stormwater and wastewater management programs. In areas served by combined sewers, the City manages stormwater before it enters the County sewers; the County manages the stormwater after it enters the County sewers. In areas served by separated sewers, the City manages most of the stormwater.³ County policy prohibits construction of facilities to handle “clean” stormwater from separated sewers managed by the City or other agencies. Stormwater causes extreme variations in wastewater flows, resulting in the need for large facilities and in challenges to the treatment process.

1.4 Why Reduce CSOs?

The mission of King County’s Wastewater Treatment Division (WTD) is to protect public human health and the environment by conveying and treating the region’s wastewater. Human waste has long been recognized as a source of serious health risks, such as infant diarrhea and cholera. Public health and life expectancy can be improved dramatically when wastewater is properly managed. Regional improvements in collecting, conveying, and treating wastewater that were made after the formation of Metro in 1958 continue to be effective despite decades of population growth and development.

Although they are highly diluted, CSOs release potentially harmful bacteria and pollutants, may cause aesthetic degradation, and may reduce sediment quality near the discharge sites. Regulations, agreements, policies, and public perceptions require, either directly or indirectly, the reduction of CSOs to protect water quality, sediment quality, and aquatic species in our water bodies. WTD makes a policy of designing, constructing, operating, and maintaining its facilities to meet or exceed regulatory requirements.

1.4.1 Water Quality Regulations

In 1972, the federal Clean Water Act was adopted. The primary objective of the Clean Water Act (CWA) is to restore and maintain the integrity of the nation’s waters. This objective translates into two national goals: to eliminate the discharge of pollutants into the nation’s waters and to achieve and maintain fishable and swimmable waters. One way that the first goal is being achieved is through the National Pollutant Discharge Elimination System (NPDES) permit program. The second goal is being addressed by developing pollution control programs to meet specific water quality standards for water bodies.

CWA requires all wastewater treatment facilities and industries that discharge effluent into surface waters to have an NPDES permit. NPDES permits are issued by Ecology and set limits on the quality and quantity of effluent discharged from point sources such as treatment plants,

³ The County is responsible for the stormwater that results from County sewer separation projects; it also accepts contaminated stormwater from industries and charges a fee to recover costs.

CSOs, and industrial facilities. King County holds NPDES permits for its West Point, South, and Vashon Treatment Plants. The West Point NPDES permit includes the Alki and Carkeek CSO treatment plants, the CSO outfalls, and the newly constructed Mercer/Elliott West and Henderson/Norfolk CSO storage and treatment facilities.

To evaluate water quality and to set permit limits to protect water quality, Ecology has put into regulation use-based Water Quality Standards (WAC 173-201A)—aimed at keeping waters clean and safe for people, fish, and wildlife. The biological, chemical, and physical criteria used to assess a water body’s health include fecal coliform bacteria, dissolved oxygen, temperature, pH, ammonia, turbidity, and a variety of other chemical compounds. These standards apply to the area in a water body that extends beyond a defined “mixing zone,” where a CSO discharge mixes with the ambient water.

When a water body does not meet these Water Quality Standards, Section 303(d) of the CWA requires that the water body be added to a list of impaired waters called the “303(d) list.” The 303(d) list is published every 4 years. Once listed, the water body must be studied and controls must be put into place that will correct conditions so that it meets standards. Controls often involve dividing the pollutant load into allocations to its sources, such as stormwater runoff and municipal or industrial discharges, that the water body can assimilate and still meet the standards. This process is called a Total Maximum Daily Load (TMDL). Most of the water bodies where King County CSOs occur are on the 303(d) list and will require TMDLs.

Regulations that Affect CSO Control Planning

Clean Water Act (CWA)—Adopted in 1972 to eliminate the discharge of pollutants into the nation’s waters and to achieve and maintain fishable and swimmable waters.

National Pollutant Discharge Elimination System (NPDES)—The Washington State Department of Ecology (Ecology) implements the CWA by issuing NPDES permits to wastewater agencies and industries that discharge effluent (including CSOs) to water bodies.

Water Quality Standards—To implement CWA, Ecology has developed biological, chemical, and physical criteria to assess a water body’s health and to impose NPDES permit limits accordingly.

State CSO Control Regulations—Ecology requires agencies to develop plans for controlling CSOs at the earliest possible date so that an average of one untreated discharge per year occurs at each location.

Wet Weather Water Quality Act of 2000—The U.S. Environmental Protection Agency (EPA) requires agencies to implement Nine Minimum Controls and to develop long-term CSO control plans.

Sediment Quality Standards—Ecology developed chemical criteria to characterize healthy sediment quality and identified a threshold for sediment cleanup. King County has participated in sediment cleanup at some of its CSO locations.

Endangered Species Act (ESA)—Two fish species that use local water bodies where CSOs occur have been listed as threatened under ESA.

1.4.2 CSO Control Regulations

In 1984, Ecology introduced legislation requiring agencies with CSOs to develop plans for “the greatest reasonable reduction [of CSOs] at the earliest possible date.” In January 1987, Ecology published a new regulation (WAC 173-245) that defined the greatest reasonable reduction in CSOs as “control of each CSO such that an average of one untreated discharge may occur per year.” The new regulation also defined standards for treated CSOs.

The U.S. Environmental Protection Agency's (EPA's) 1990 CSO Control Policy was codified as the Wet Weather Water Quality Act of 2000 (H.R. 4577, 33 U.D.C. 1342(q)). This act requires implementation of Nine Minimum Controls for CSOs and the development of long-term CSO control plans. The purpose of the Nine Minimum Controls is to implement early actions that can improve water quality before the more expensive capital projects in the control plan are built. The requirements of this act are incorporated in the NPDES permit for the West Point plant.

1.4.3 Sediment Quality Regulations

Ecology is granted legal authority under WAC 173-204, Sediment Management Standards, to direct the identification, screening, ranking, prioritization, and cleanup of contaminated sediment sites in the state. The standards include the sediment quality standards (SQS), which are chemical-specific criteria that designate what is considered healthy sediment quality, and a threshold called the Cleanup Screening Level (CSL) for sediment cleanup efforts ("remediations"). When these chemical criteria are exceeded, toxicity testing may be used to verify the adverse impact. Once a site is ranked and placed on the contaminated sites list, it may then be considered for cleanup. WAC 173-204 provides for the voluntary cleanup of contaminated sediments with oversight and guidance by Ecology. Alternatively, Ecology or EPA may initiate enforcement actions (including cost recovery) under the Washington Model Toxics Control Act (MTCA) or the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), also known as Superfund.

1.4.4 Endangered Species Act

In 1999, chinook salmon and bull trout were listed as threatened species under the Endangered Species Act (ESA).⁴ In 2000, NOAA Fisheries adopted a draft protective rule under section 4(d) of ESA prohibiting the "take" of the listed species.^{5,6} Following the adoption of the rule, King County began a review of its activities to determine how WTD should modify its practices, including construction practices and uses of property near water bodies, to stay within the parameters set out in the 4(d) rule.

For treatment plant discharges, NOAA stated in the 4(d) rule that it would work with permitting authorities (Ecology) to ensure that permitted discharges do not violate ESA. NOAA Fisheries, the U.S. Fish and Wildlife Service (USFWS), and EPA have signed a Memorandum of Agreement to work together on integrating the CWA standards and the ESA requirements. Both NOAA Fisheries and USFWS have the opportunity to review NPDES permits.

⁴ In February 2006, killer whales were listed as endangered under the ESA.

⁵ NOAA (National Oceanographic and Atmospheric Administration) Fisheries was formerly known as the National Marine Fisheries Service.

⁶ Take under ESA means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct [ESA §3(19)].

1.4.5 Public Perception and Preferences Regarding CSOs

King County's 1998 *Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay* included valuable input from regional stakeholders. The message heard during this process and during RWSP formation—that water quality is a priority to the citizens of King County, that the County has a mandate to protect and enhance water quality, and that the citizens believe CSOs should be controlled—has been continually reaffirmed through all WTD public involvement activities since the RWSP was adopted. In a recent survey, 75 percent of the respondents said that CSOs should be prevented even if the effort increases sewer rates.

1.4.6 Policy Commitments and Agreements

In adopting the RWSP, King County set policies for completing CSO control by 2030. The CSO control plan in the RWSP identifies 21 projects that, when completed, will bring all County CSOs into compliance with the one-per-year discharge requirement by 2030. The plan conforms to RWSP policies by giving priority to CSO control projects in areas where discharges have the greatest potential to impact human health and/or species listed under ESA. The RWSP policy also recognizes that plans and priorities must adapt to changing conditions.

Other commitments include the commitment to reserve capacity at the West Point plant for CSO control and the agreements made with regional elected officials on how to fund the RWSP, including CSO control.

1.5 What Is King County Doing to Control CSOs?

The County prepares and updates its CSO control plan to reflect the current state of science and regulation and to integrate CSO control with other WTD capital improvement programs. Various strategies to monitor and control CSOs include controlling pollution at its sources, maximizing use of existing system capacity, monitoring and modeling flows in the system, and constructing new CSO control facilities.

To save costs and to provide a high level of treatment, WTD operates its system so that to the extent possible, CSO flows are sent to regional plants for secondary treatment. An automated control system manages flows through the conveyance system so that the maximum amount of flow is contained in pipelines and storage facilities until it can be conveyed to the plant. In some areas of the system where flows cannot be conveyed to the plant, the flows are sent to CSO treatment facilities for CSO treatment prior to discharge. Untreated CSOs are discharged only when flows exceed the capacity of these systems.

Construction of CSO control facilities in the region began in the late 1970s. So far, about \$320 million has been spent to control CSOs and another \$383 million is planned to implement the CSO control projects in the RWSP. Many early projects involved sewer separation, flow diversion, and storage tunnels. Most current and future projects involve construction of

conveyance improvements, storage tanks, and treatment facilities. In 2005, two major facilities were finished. The Mercer/Elliott West system, done in collaboration with the City of Seattle and completed at a cost about \$140 million, includes two improved outfalls, a tunnel that both stores and treats flows, and additional treatment facilities. The Henderson/Norfolk system, completed at a cost of \$77 million, also includes a large storage/treatment tunnel and additional treatment facilities.

Since 1988, when monitoring and measuring of CSO flows began, these control efforts have reduced CSO volumes from an estimated 2.4 billion gallons per year to approximately 900 million gallons per year (Figure 1-4). The County is committed to reducing CSOs even further in the years ahead.

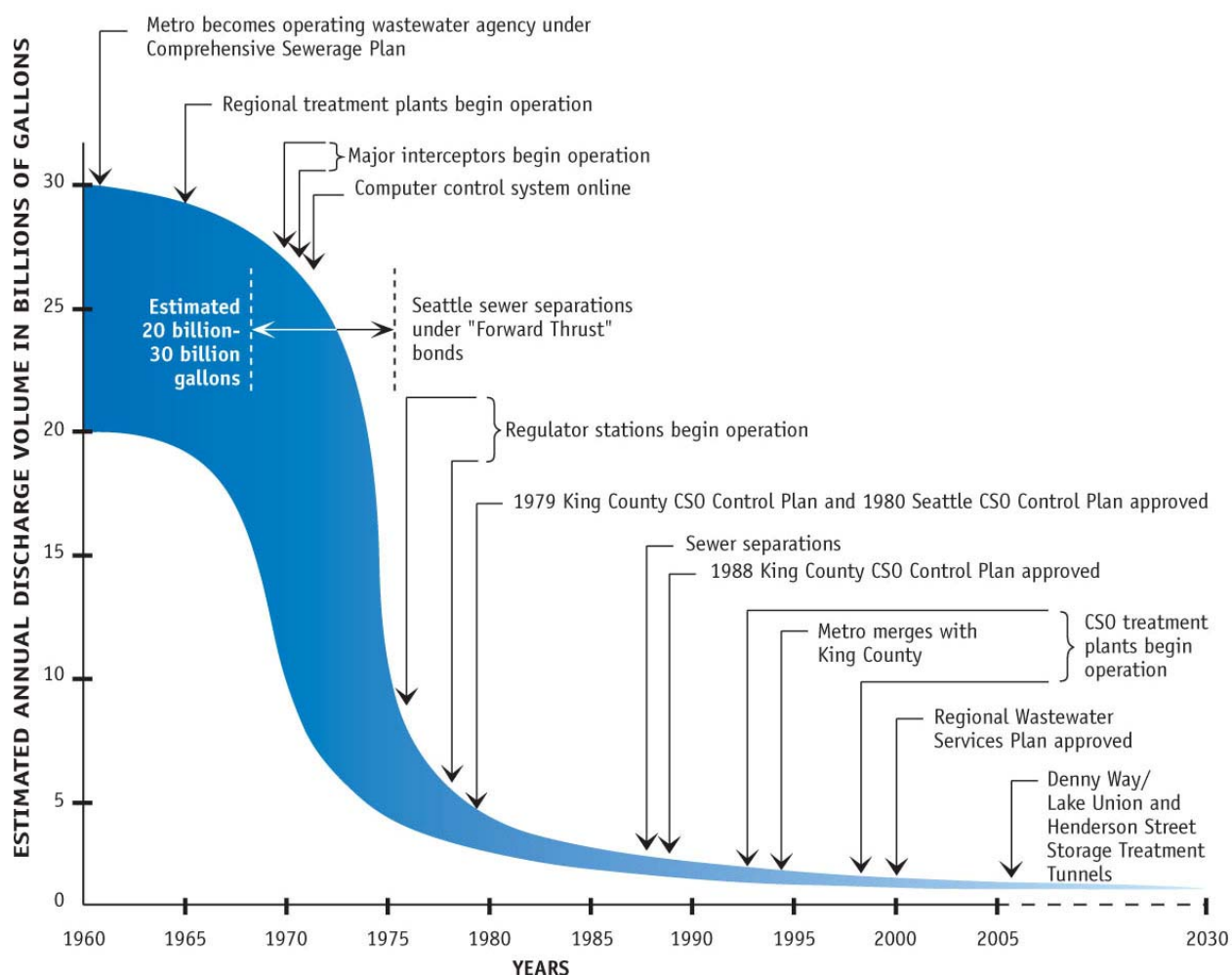


Figure 1-4. Reduction in CSO Volumes Over Time

Chapter 2

History of CSO Planning

Planning for CSO control is a dynamic process that must respond to changing regulations and conditions. The first CSO control plan was completed in 1979 to address CSOs into Lake Washington. The most recent CSO control plan covers all CSOs in the County system. This latest plan was included as a part of the 1999 Regional Wastewater Services Plan (RWSP), which amended King County's comprehensive sewer plan.

This chapter presents a history of CSO planning in the County both before and after adoption of the RWSP. It also describes plan updates and reviews scheduled for the near future. Figure 2-1 graphically represents this progression.

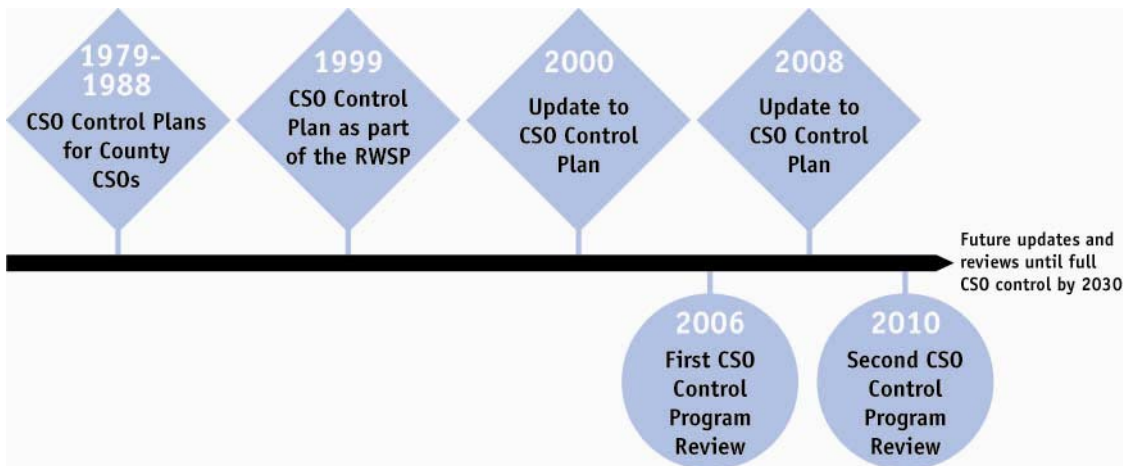


Figure 2-1. Past and Future CSO Control Planning

2.1 CSO Planning Prior to the RWSP

In response to the Clean Water Act of 1972, Metro adopted its first *Combined Sewer Overflow Control Program* in 1979. Before projects in the program were fully implemented, Metro decided to incorporate CSO planning into a larger system-wide planning effort that was launched to meet new secondary treatment regulations for wastewater treatment plants.

In 1985, Metro published the *Plan for Combined Sewer Overflow Control*. Concurrent with this planning, the State of Washington amended the Water Pollution Control Act (RCW 90.48) to require all municipalities with CSOs to develop plans for “the greatest reasonable reduction at the earliest possible date.”

In 1986, in response to RCW 90.48, Metro issued the *Supplemental Plan for Combined Sewer Overflow Control*. The supplemental plan evaluated CSO control projects that would achieve 75 and 90 percent volume reductions and documented the results of upgraded computer modeling of the system.

In 1987, Ecology published a new CSO regulation. It defined the “greatest reasonable reduction” in CSOs (RCW 90.48) as “control of each CSO in such a way that an average of one untreated discharge may occur per year” (WAC 173-245-020). The CSO regulation required each community to submit a CSO plan by 1988 that would specify the means of complying with the new CSO control standard and then to update the plan at the time of NPDES permit renewals, intended to occur at least every 5 years.

Metro worked with Ecology to develop a revised CSO plan—the *1988 Combined Sewer Overflow Control Plan*. The plan established an interim goal of achieving a 75 percent CSO volume reduction system wide by the end of 2005 and described additional projects intended to achieve the ultimate goal of an average of no more than one untreated event per year for each CSO.

As part of the 1995 NPDES permit renewal for the West Point Treatment Plant, King County prepared an update and amendment to the 1988 plan. The *1995 CSO Control Update* assessed the effectiveness of CSO reduction efforts to date, reevaluated priorities for control of CSO sites, and identified work to be completed on three control projects in 1995–2000: Denny Way/Lake Union, Henderson Street/Martin Luther King, Jr., and Harbor CSO projects.

A History of CSO Plans

1979—Metro adopted its first *Combined Sewer Overflow Control Program*.

1985 and 1986—The *Plan for Combined Sewer Overflow Control* and the *Supplemental Plan for Combined Sewer Overflow Control* were prepared as part of a system-wide planning effort

1988—The *1988 Combined Sewer Overflow Control Plan* was prepared in response to Ecology’s 1987 definition of control as one untreated discharge per year.

1995—As part of the 1995 West Point NPDES permit renewal, King County prepared an update and amendment to the 1988 plan.

1999—A CSO control plan was adopted as part of the RWSP. The plan lists 21 control projects to bring all CSOs into control by 2030.

2000—The RWSP CSO control plan was updated as part of the West Point NPDES permit renewal. No changes to the RWSP CSO control plan were recommended.

2.2 CSO Planning in the RWSP

The RWSP integrates long-range planning in all areas of wastewater services—treatment and conveyance, biosolids reuse, CSO control, and water reuse. The RWSP outlines wastewater projects to be built between 2000 and 2030 to protect human health and the environment, serve population growth, and meet regulatory requirements. As noted previously, the RWSP includes King County’s CSO control plan. The plan lists 21 CSO control projects to reduce CSOs to one untreated event per year on average at each CSO location.

Several assumptions guided the development of the CSO plan in the RWSP. These assumptions included conditions around which plans must be developed, such as population and the average amount of rainfall in a year, and values and practices, such as protecting human health and the

environment. These assumptions, as well as changes to them since the RWSP was adopted in 1999, are listed in Appendix A.

Also in the RWSP are nine CSO control policies approved by the King County Council in 1999. These policies are intended to guide the Wastewater Treatment Division (WTD) in controlling CSO discharges and in prioritizing planned CSO projects. These policies institutionalized several values and practices, provided guiding principles, and called for specific tasks to be done. These policies and the status of their implementation are listed in Appendix A.

The CSO control projects were prioritized according to the CSO policies. The CSO projects given the highest priority were projects near bathing beaches with recreational uses such as swimming where high direct contact with the water occurs (Figure 2-2 and Table 2-1). Thus, projects at CSOs that discharge near beaches on Puget Sound are scheduled for completion next. The priorities, as shown in Figure 2-2, are as follows:

- **Priority 1, CSOs near Puget Sound Beaches.** The current schedule calls for completion of the Barton, Murray, North Beach, and South Magnolia projects is 2012.
- **Priority 2, The University/Montlake CSO.** This CSO is located at the east end of the Ship Canal. The control project was given a high priority because of the high level of boating in that area, which could result in secondary contact with the water.
- **Priority 3, CSOs Along the Duwamish River and in Elliot Bay.** The RWSP designated that nine projects at CSOs along the Duwamish River and in Elliott Bay be completed by 2027. These projects were given third priority because the 1998 *Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay* indicated that the level of pollution originating upstream of CSOs was high enough to dwarf improvements by CSO control projects.
- **Priority 4, CSOs at the West End of the Ship Canal.** Three projects to control CSOs at the west end of the Ship Canal (Ballard, 3rd Avenue West, and 11th Avenue West) are scheduled as the last projects to be completed because significant CSO control had already been accomplished in this area prior to the RWSP.

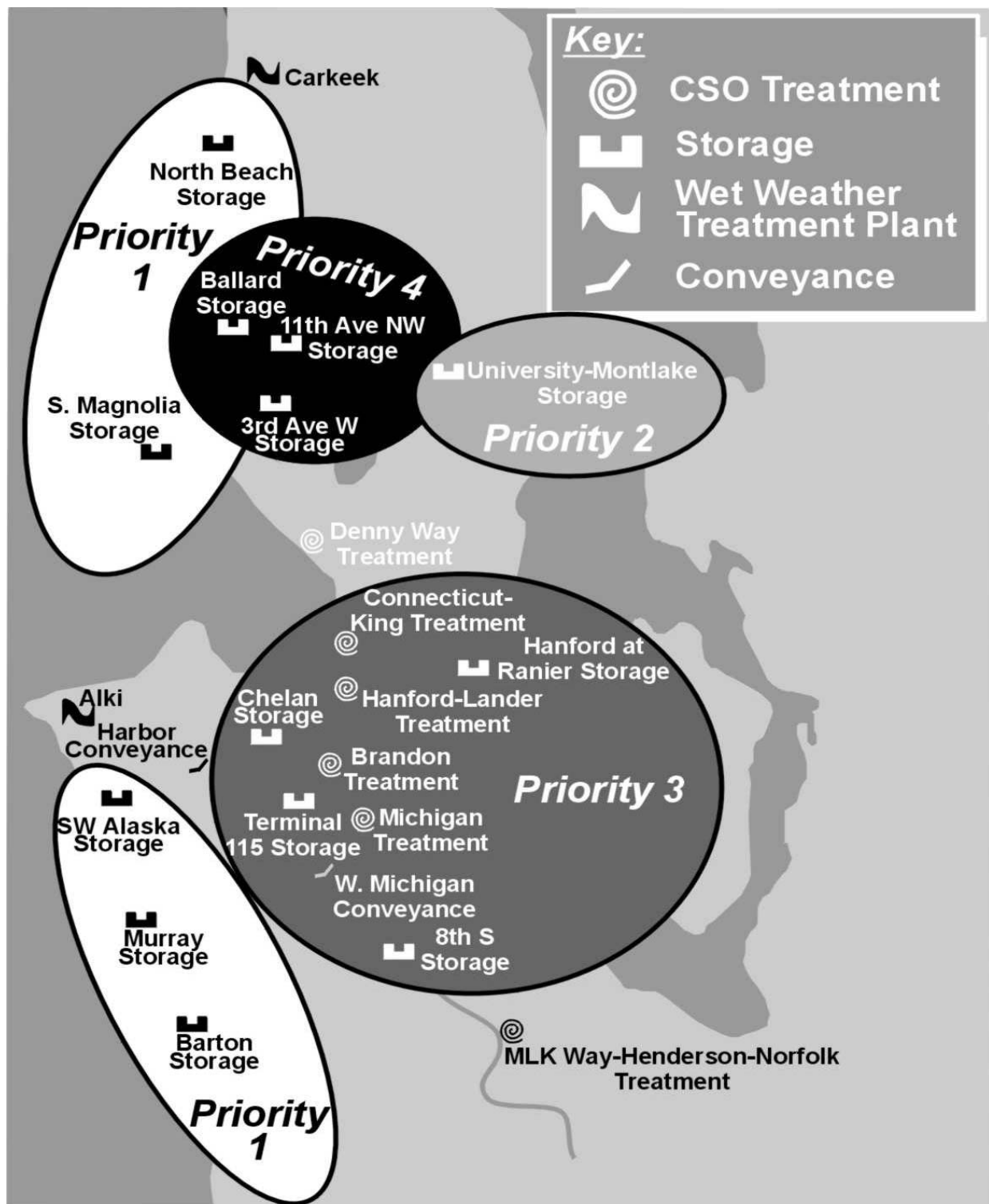


Figure 2-2. Priority of CSO Projects

Table 2-1. CSO Projects in Order of Priority in RWSP

Project Name	DSN ^a	Project Description	Projected Year of Control	Water Body
South Magnolia	006	1.3 MG storage tank	2012 ^c	Puget Sound
SW Alaska Street ^b	055	0.7 MG storage tank	Controlled	Puget Sound
Murray Avenue	056	0.8 MG storage	2012 ^c	Puget Sound
Barton Street	057	Pump station upgrade	2012 ^c	Puget Sound
North Beach	048	Storage tank and pump station expansion	2012 ^c	Puget Sound
University/Montlake	015/ 014	7.5 MG storage	2015	Lake Union/ East Ship Canal
Hanford #2	032	3.3 MG storage/treatment tank	2017	Duwamish River
West Point Treatment Plant Improvements		Primary/secondary enhancements	2018	Puget Sound
Lander Street	030	1.5 MG storage/treatment at Hanford	2019	Duwamish River
Michigan	039	2.2 MG storage/treatment tank	2022	Duwamish River
Brandon Street	041	0.8 MG storage/treatment tank	2022	Duwamish River
Chelan Avenue	036	4 MG storage tank	2024	Duwamish River
Connecticut Street	029	2.1 MG storage/treatment tank	2026	Elliott Bay
King Street	028	Conveyance to Connecticut Street treatment	2026	Elliott Bay
Hanford at Rainier Avenue	031	0.6 MG storage tank	2026	Duwamish River
8th Avenue S	040	1.0 MG storage tank	2027	Duwamish River
West Michigan	042	Conveyance upgrade	2027	Duwamish River
Terminal 115	038	0.5 MG storage tank	2027	Duwamish River
3rd Avenue W	008	5.5 MG storage tank	2029	West Ship Canal
Ballard	003	1.0 MG storage tank (40% King County)	2029	West Ship Canal
11th Avenue West	004	2.0 MG storage tank	2030	West Ship Canal

^a DSN refers to the Discharge Serial Number, an identifier set in the NPDES permit for an individual CSO location. See Figure 1-3 in Chapter 1 for locations of CSOs.

^b Updated monitoring and modeling data indicate that the SW Alaska Street CSO is already controlled; thus, the project is no longer needed.

^c In the RWSP, the Barton, Murray, North Beach, and South Magnolia projects were scheduled to be completed in 2010 or 2011. They are now scheduled to be completed in 2012.

2.3 Post-RWSP CSO Plan Updates and Program Reviews

Both Ecology's CSO regulation (WAC 173-245) and King County's RWSP policies require WTD to submit a CSO plan update to Ecology that coincides with each NPDES permit renewal for the West Point Treatment Plant. Updates are intended to describe WTD's progress on its CSO program to date, identify its program for the next 5 years, and provide a vehicle for making changes in the overall long-term CSO control program. WTD prepared such an update in 2000 (see below) when the West Point NPDES permit renewal was submitted to Ecology.

In addition to updates, the RWSP policies call for a CSO control program review to be done prior to the plan update that would occur as a part of the next NPDES permit renewal following the plan update and permit renewal in 2000. At the time the RWSP was prepared, the update and permit renewal were anticipated to be due in 2005. Ecology subsequently determined that the next NPDES permit renewal will be due in 2008. The CSO program review is now completed—well ahead of the 2008 Ecology-required update and permit renewal—providing the Council and the Regional Water Quality Committee (RWQC) time to comment on or make any needed recommendations to modify the CSO program.

2.3.1 2000 CSO Plan Update

The required update of the CSO control plan—*Year 2000 CSO Control Plan Update*—was included in the June 2000 submission of the West Point Treatment Plant NPDES permit renewal application to Ecology. The update reflected direction provided by the RWSP, adopted 6 months before.

The 2000 CSO plan update described King County's progress in implementing its CSO control program, documented its compliance with federal and state CSO control requirements, and identified two large CSO control projects—Denny Way/Lake Union and Henderson/Martin Luther King, Jr./Norfolk—for completion in the next 5-year NPDES permit cycle.¹

The update also identified concerns related to historically contaminated sediments near CSO discharge locations; identified some emerging technologies to be considered during predesign of future CSO control projects; and discussed new studies, initiatives, and regulations that affect CSO planning and control. It highlighted the potential impacts of new regulations that could be adopted to meet the requirements of the Endangered Species Act and to address contaminated sediment concerns.

¹ Both of these projects were completed in May 2005. The remainder of this report uses the names for the completed systems—Mercer/Elliott West and Henderson/Norfolk—rather than the project names. (See Chapter 3 for a description of these systems).

2.3.2 CSO Program Review

The CSO program review called for in the RWSP policies is described in Policy CSOCP-8, which states in part:

...the executive shall evaluate the benefits of CSO control projects along with other pollution control projects developed by King County and other agencies. This CSO program review will include, but not be limited to the following: maximizing use of existing CSO control facilities; identifying the public and environmental health benefits of continuing the CSO control program; ensuring projects are in compliance with new regulatory requirements and objectives such as the Endangered Species Act (ESA) and the Wastewater Habitat Conservation Plan; analyzing rate impacts; ensuring that the program review will honor and be consistent with long-standing existing commitments; assessing public opinion; and integrating the CSO control program with other water/sediment quality improvement programs for the region.

WTD completed the required review; Chapter 4 of this document and supporting appendices report the findings.

2.3.3 Future Updates and Program Reviews

If, in response to this CSO program review, the King County Council makes recommendations for changes to the CSO control program, those changes will be incorporated into the control plan update that will be submitted to Ecology with the NPDES permit renewal in 2008.

WTD intends to perform another program review in 2010. The review will consider several factors, including monitoring data, modeling data from an updated and recalibrated hydraulic model, scientific developments, results of pilot projects of treatment technologies, changes in regulations, results of cost-effectiveness efforts, and updated cost estimates. Conducting a program review in 2010 will also provide the RWQC and County Council sufficient time to review and make recommendations for the CSO plan update prior to submitting the West Point NPDES permit renewal application, anticipated to occur in 2013 if Ecology meets a 5-year permitting cycle.

While changes may be proposed in projects or in their order of construction, all projects are scheduled for completion by 2030. When the projects have been completed, King County will have controlled all of its CSOs to one untreated discharge per year on average as required by Ecology regulations.

2.4 Additional Planning and Environmental Review

King County evaluates and performs environmental review of all proposed programs and project alternatives. The current CSO program was presented and evaluated as part of a programmatic review in the *Regional Wastewater Services Plan Draft* and *Final Environmental Impact Statements*. As individual CSO projects are designed, project-specific environmental review of alternative designs for facilities and the impacts of constructing and operating those facilities occurs. The type of environmental review may range from a State Environmental Policy Act (SEPA) Determination of Non-Significance and Environmental Checklist to a National Environmental Policy Act (NEPA) Determination of Significance and Environmental Assessment and ESA Section 7 review.

Progress Toward CSO Control

King County has made significant progress in controlling CSOs during the past two decades. Despite fluctuations in rainfall from year to year, there is a pattern of decreasing volumes of CSO discharges over time (Figure 3-1).

This chapter describes the baseline used for measuring progress, explains how computer modeling and direct measurement are used to determine the frequency and volume of CSOs, and describes King County’s approach to controlling CSOs.

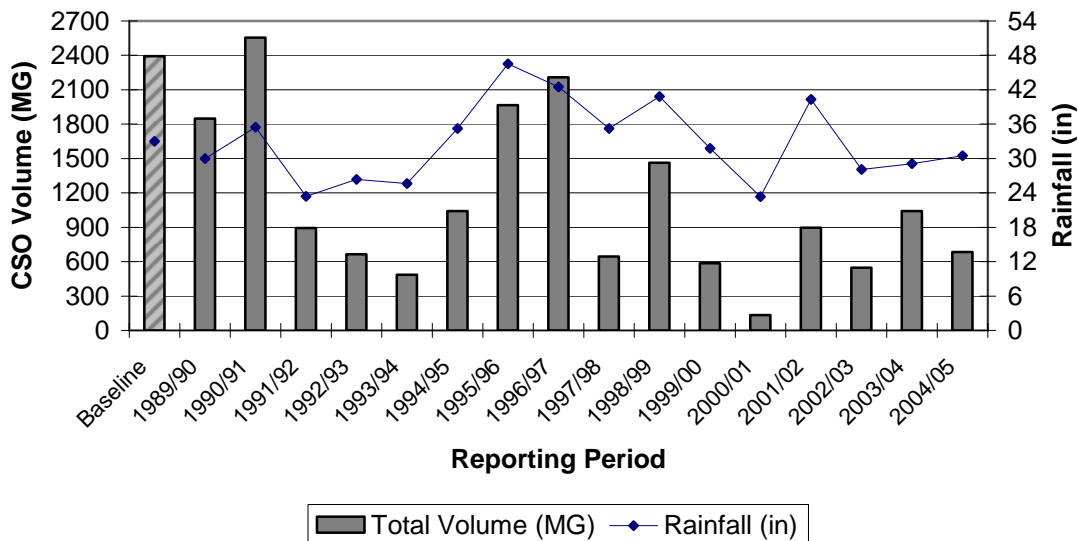


Figure 3-1. Annual CSO Volumes Relative to Total Rainfall

3.1 Measuring Progress in CSO Control

The Washington State Department of Ecology (Ecology) regulates the level of CSO control based on the number of untreated CSO events that occur in a year. Ecology defines “the greatest reasonable reduction” in CSOs (RCW 90.48) as being “control of each CSO in such a way that an average of one untreated discharge may occur per year” (WAC 173-245-020). Ecology recognizes that rainfall varies from year to year and thus assesses compliance with this goal as an average over the life of the National Pollutant Discharge Elimination (NPDES) permit for the CSO system, which is usually 5 years.

King County uses flow monitors in conjunction with a sophisticated supervisory control and data acquisition (SCADA) system to track both the frequency and volume of CSO events. The County models this and other information, such as rainfall patterns, to predict system behavior

and to plan for future CSO control facilities. The following sections describe King County's monitoring and modeling efforts, preceded by a discussion of how Ecology defines a CSO event.

3.1.1 Defining an Overflow Event

In order to determine whether King County is in compliance with Ecology's requirement to have no more than an average of one untreated discharge per year at each CSO location, it is necessary to define what constitutes a CSO event. A CSO event is defined by the length of the dry period (inter-event interval) after an overflow. Discharges are considered as one event, even if they start and stop several times during a storm, as long as the length of time between each discharge is less than the required inter-event interval. This definition of an event reflects the expectation that all overflows resulting from a single rainstorm should count as only one overflow. The County, in consultation with Ecology, developed and used a 48-hour interval for the RWSP modeling based on its analysis of local rainfall and the wastewater system's response to that rainfall.

Over the years, the interval used to define a CSO event has changed from 3 hours (1986–1995), to 48 hours (1995–2000), to 24 hours (2000 to present). The change to the 24-hour definition from the 48-hour definition resulted when Ecology decided to apply a single definition for all CSO agencies in the state. While the 24-hour definition fits some agency situations better than others because of variations in rainfall patterns, the change had only a minimal effect on the County's CSO control efforts.¹ Figure 3-2 gives an example of how an event is determined based on a 24-hour inter-event interval.

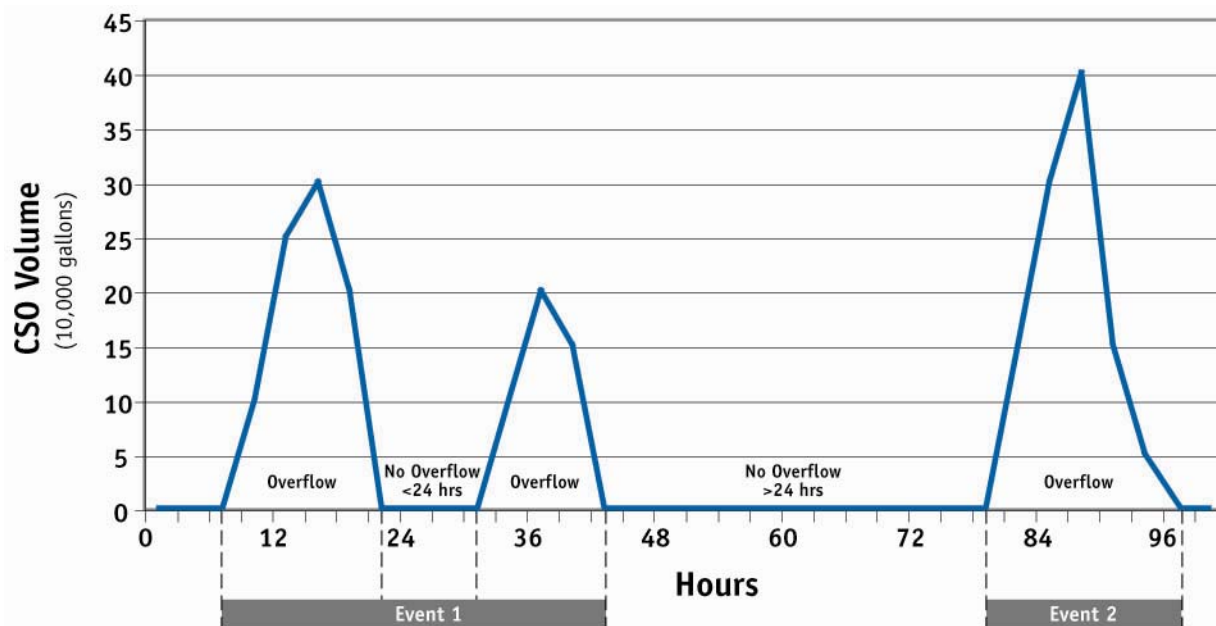


Figure 3-2. Defining CSO Events Using a 24-Hour Inter-Event Interval

¹ In the West Point NPDES permit, Ecology established that an event for **treated** CSOs would be defined based on a 48-hour inter-event interval.

3.1.2 CSO Monitoring and Modeling

King County uses both monitoring and modeling to assess the frequency and volume of CSOs. Monitoring consists of directly measuring overflows with flow meters or measuring the depth or flow level in a pipe with a known geometry and then using the data to calculate flow values. King County continuously monitors the frequency and volume of overflows at locations where flow control occurs within the wastewater system, such as at regulators or pump stations. Portable monitors, which must be manually downloaded at set time intervals, are used at other locations. Data collected from monitoring of actual overflows as they occur is used to determine compliance with Ecology regulations.

Because overflows vary with the pattern of rainfall from year to year, it is difficult to use monitored data to assess system capacity and progress in CSO control. One way to achieve consistency is to use a computer model to estimate the frequency and volume of overflows that would occur under average rainfall in the service area.² Modeled data is compared to monitoring data, and the model is calibrated (adjusted) to provide more accurate predictions for use in CSO program planning and facility design. (King County's approach to modeling is described later in this chapter.)

CSO Monitoring and Modeling

Flow Monitoring—A combination of flow monitors and a computerized control system tracks both the frequency and volume of CSO events.

Modeling—Computerized modeling programs use flow monitoring data and other data, such as rainfall patterns, to predict system behavior and to plan for future CSO control facilities.

The County reports both monitored and modeled CSO data beginning in June of one year and ending in May of the next year; this approach reports on one continuous wet season rather than arbitrarily reporting the data based on calendar year. King County uses the period between 1981 and 1983 as the baseline for measuring progress in controlling CSOs. Baseline volumes were determined using computer modeling. The model used rainfall data from that period and other parameters, such as system capacity and the amount of permeable and impermeable surfaces in the service area at that time, to determine what the frequency and volume of CSO flows would have been. The 1981–1983 modeled baseline for the system is estimated as 471 CSO events (frequency) and 2,339 million gallons (volume) per year. The modeled prediction done in 1999 indicated a decrease from the baseline in frequency to 332 events and volume to 1,536 million gallons. Frequency and volume based on actual measurements for 2000–2005 were lower than these predictions—186 events and 736 million gallons per year on average—possibly because the rainfall for that period was lower than average. Table 3-1 compares the modeled estimates to the monitored frequency and volume for the 2000–2005 wet seasons

Two major King County control systems, the Mercer/Elliott West and Henderson/Norfolk systems, came online in May 2005. Their effect on CSO control is not yet reflected in monitoring and modeling data reported in Table 3-1. It is anticipated that these systems will reduce untreated overflow volumes by one-third of the modeled 1999 prediction.

² King County rain gauges indicate that the average rainfall in the wastewater service area is 34 inches per year.

**Table 3-1. Annual Average Number and Volume of Untreated CSOs:
Monitored CSOs Compared to Modeled CSOs**

CSO Location	DSN	Frequency of Overflows			Volume of Overflows (annual average in million gallons)		
		Modeled Baseline 1981–1983	Modeled 1999	Monitored 2000–2005	Modeled Baseline 1981–1983	Modeled 1999	Monitored 2000–2005
11th Ave. NW	004	16	15	9	NA	18	5.06
30th Ave. NE	049	<1	<1	0	<1	<1	0.00
3rd Ave. W.	008	17	8	6	106	42	4.41
53rd Ave. SW	052	<1	<1	0	<1	<1	0.00
63rd Ave. PS	054	2	1	1	10	1	1.26
8th Ave./W. Marginal Way ^a	040	6	6	0	8	8	0.00
Alaska St. SW	055	1	1	0	<1	<1	0.00
Ballard	003	13	8	2	95	6	0.27
Barton	057	9	8	2	8	8	1.47
Belvoir	012	<1	<1	1	<1	<1	0.67
Brandon St.	041	36	28	25	64	49	34.59
Canal St.	007	<1	1	0	1	1	0.00
Chelan	036	7	7	3	61	32	1.40
Kingdome	029	29	10	7	50	79	28.51
Denny Way	027	32	24	21	502	449	298.96
Dexter	009	15	15	11	24	24	22.01
Duwamish Pump Station and Siphon, East	034	<1	1	0	<1	1	1.97
Duwamish Siphon, West ^b	035	Not modeled ^b	Not modeled ^b	Not monitored ^b	Not modeled ^b	Not modeled ^b	Not monitored ^b
Hanford #1 (Hanford @ Rainier)	031	30	11	5	378	65	11.90
Hanford #2	032	28	15	12	266	210	70.82
Harbor Ave.	037	30	26	1	36	36	7.48
Henderson	045	12	7	10	15	2	8.26
King Street	028	16	14	14	55	38	23.40
Lander St.	030	26	12	10	143	100	97.78

CSO Location	DSN	Frequency of Overflows			Volume of Overflows (annual average in million gallons)		
		Modeled Baseline 1981–1983	Modeled 1999	Monitored 2000–2005	Modeled Baseline 1981–1983	Modeled 1999	Monitored 2000–2005
Magnolia, S.	006	25	21	10	14	14	14.66
Marginal, E.	043	<1	<1	0	<1	<1	0.00
Matthews Park	018	<1	<1	0	<1	<1	0.00
Michigan St.	039	34	28	8	190	150	23.04
Michigan, W.	042	5	5	4	2	2	0.90
MLK Jr. Way	013	16	15	2	60	60	22.49
Montlake	014	6	5	5	32	32	29.68
Murray	056	5	5	3	6	6	2.72
Norfolk St.	044	20	4	2	39	5	0.48
North Beach	048	18	17	9	6	6	2.39
Pine St., E	011	<1	<1	0	<1	<1	0.00
Rainier Ave.	033	<1	1	0	<1	<1	0.00
Terminal 115	038	4	3	2	2	2	2.82
University	015	13	10	4	126	90	34.84
TOTAL		471	332	186	2,339	1,536	736.10

^a Recent data suggest that the 8th Avenue/West Marginal Way CSO may be controlled. King County is doing additional analysis to confirm this.

^b Duwamish Siphon West was reactivated in the NPDES permit in 2004 because of concerns that it could overflow. Monitoring is now in place.

NOTES:

- Shading indicates that a CSO is controlled to the Ecology standard of an average of no more than one untreated event per year.
- The County reports both monitored and modeled CSO data beginning in June of one year and ending in May of the next year.
- Baseline frequency modeling has been updated to the new 24-hour inter-event interval. Modeled 1999 frequency data, which are still based on a 48-hour inter-event interval, have not been updated.
- Modeling of the baseline (1981–1983) and for 1999 was done in 1999 using a continuous simulation model. Monitored data for 2000–2005 reflects the direct measurement of overflows.
- Modeled data predict what overflows would be under average rainfall conditions prior to completion of the Mercer/Elliott West and Henderson/Norfolk systems. These projects were completed in May 2005. Monitored data reflect CSOs under actual rainfall experienced during 2000–2005.
- Baseline and 1999 volumes are reported as whole numbers because they are modeled numbers. Volumes for 2000–2005 are reported to two decimal places because they reflect direct measurement of actual flows.
- Data that show <1 were not included in the total.

3.1.3 Approach to Modeling

WTD uses computer models to simulate stormwater and wastewater flow contributions to the wastewater system under various conditions. These simulations, combined with field data and engineering judgment, are used in the design and operation of facilities, such as CSO control facilities.

The different models that WTD has used over the past 30 years are described in Appendix B. For the RWSP, the types and sizes of CSO control projects were determined using a design storm model to predict average CSO frequencies and volumes. The design storm was representative of a storm of a specified volume, duration, and intensity that occurs once per year on average.³ WTD now uses a continuous simulation model that is based on historical rainfall patterns. The continuous simulation model simulates rainfall variability better than the design storm model and provides better long-term predictions of overflows. As the science of computer simulations improves and as more field data are collected over time, new calculations and more variables are added to the selected model to account for factors that affect the system. The revised model represents a more complete understanding of the system and results in more refined and accurate projections.

The evaluation done for this CSO program review indicates that the current model needs to be updated and recalibrated to ensure the accuracy of the predictions. Comparison between the modeled and monitoring data for 2000–2005 shows some significant differences between predicted and actual frequency and volume of CSOs (Table 3-1). Some of the differences are due to the lower than average rainfall over the 5-year period. The differences may also indicate that the wastewater system has changed in ways not captured by the model or may reflect inaccuracies in the monitored data resulting from the placement and/or operation of the monitors. In any event, because project sizing and the resulting cost of construction and operation rely on the modeled predictions, it is important for the model and measured data to be as accurate as possible. The updating and recalibration are under way and should be complete in 2007.

3.2 Approach to CSO Control

King County began to develop plans for controlling CSOs as early as 1979 (see Chapter 2). By May 2005, with completion of the projects specified in the 1988 plan and the Mercer/Elliott West and Henderson/Norfolk facilities, 17 of King County's CSOs were controlled to the Washington State standard of an average of no more than one untreated discharge per year per outfall. In meeting the Washington State standard, the federal standard of 4 to 6 events per year will also be met. The remaining 21 uncontrolled CSOs will meet state standards between 2012 and 2030. Strategies for reducing CSOs include pollution prevention through source control, operational controls, upgrade of existing facilities, and construction of new facilities to provide storage and treatment of excess flows prior to discharge. Figure 3-3 shows the estimated CSO reduction from 1988 through completion of the RWSP projects in 2030.

³ This design storm was called "Storm 6."

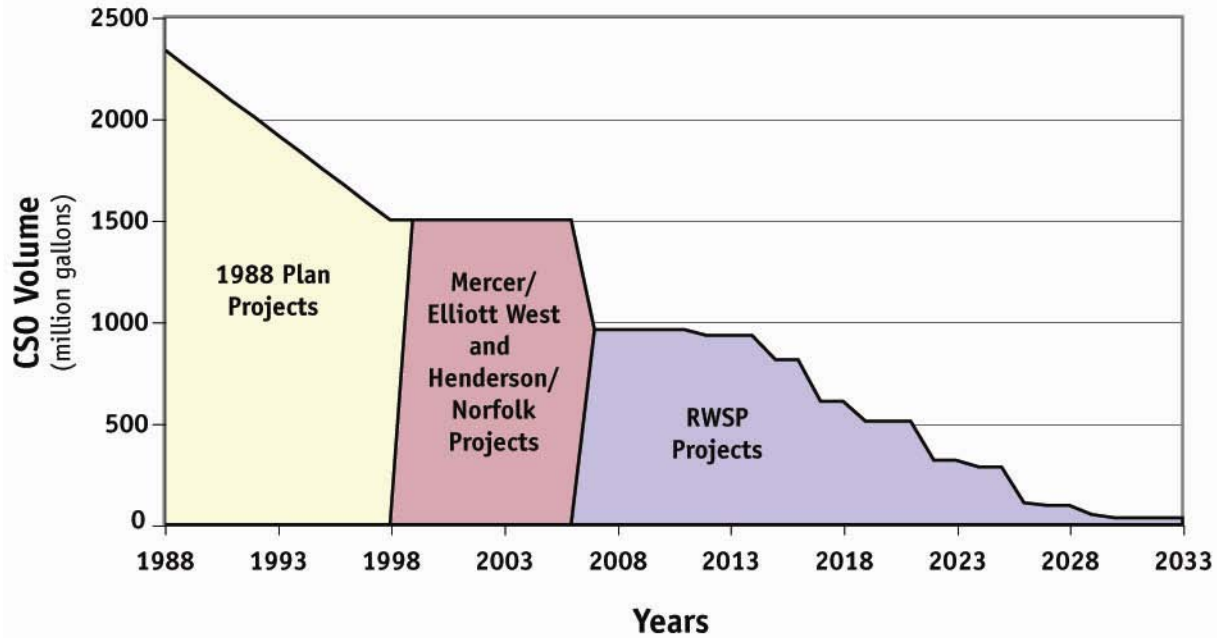


Figure 3-3. CSO Reduction Since 1988

3.2.1 Pollution Prevention and Source Control

CSO control strives not only to reduce the volume and frequency of discharges but also to prevent pollutants from entering the combined sewer system and discharging to receiving waters via CSOs. King County’s pollution prevention and source control efforts include the Industrial Waste Program and the Local Hazardous Waste Management Program. The County also participates in the Lower Duwamish Waterway Source Control Project. This project is pilot testing enhanced source control methods that if effective, could be added to future efforts.

3.2.1.1 Industrial Waste Program

The Industrial Waste Program administers King County’s industrial waste regulations for local businesses that discharge industrial wastewater to the King County sewer system. King County establishes local discharge limits; specific industries are subject to federal pretreatment requirements. Program activities include administration of waste discharge permits, inspections, enforcement, sample collection to determine compliance, and collection of surcharge and monitoring fees.

3.2.1.2 Local Hazardous Waste Management Program

WTD administers the multi-agency Local Hazardous Waste Program and funds 17 percent of the program. The goal of the program is to reduce the quantities of hazardous waste generated by households and small businesses and to divert these wastes from municipal waste streams and indiscriminate disposal in the environment. Program services include household hazardous waste education and collection; small business education, technical assistance, and compliance

assistance; small quantity generator collection and waste handling; an industrial materials exchange; and a hazardous waste library.

3.2.1.3 Stormwater Source Control

Stormwater source control is a key component of effective CSO control and prevention of sediment contamination. Stormwater management programs in the combined sewer area are operated by the City of Seattle. Until December 2005, the City conducted such programs only in the separated sewer areas. The City's new NPDES permit issued in December 2005 requires implementation of stormwater pollution prevention programs in the combined areas.⁴

3.2.1.4 Lower Duwamish Waterway Source Control Project

In 2002, King County, the City of Seattle, the Port of Seattle, and Boeing initiated the Lower Duwamish Waterway Source Control Project to increase the effectiveness of source control efforts in the Diagonal/Duwamish basin. The goal of the project is to ensure that the Lower Duwamish Waterway and Harbor Island/East Waterway Superfund sediment cleanup sites are not recontaminated. If source control in this basin is not successful, imposed solutions may include acceleration of CSO control project schedules or implementation of higher levels of control than is currently planned; either solution could require significant adjustment of the CSO control plan.

The size of this industrial area makes source control particularly challenging. Four separate programs implemented by King County Industrial Waste, King County Hazardous Waste, Public Health–Seattle and King County, and Seattle Public Utilities are now being coordinated to make it easier for businesses to identify and control pollutant sources. In the next few years, King County will determine if this approach has been successful; early monitoring of the remediated Diagonal/Duwamish site indicates that recontamination with phthalates is occurring. Additional source control efforts will need to be identified.

3.2.2 System-Wide Operational Controls

Since the early 1970s, one of King County's major tools in achieving CSO control is a SCADA system that the County has called CATAD (Computer Augmented Treatment and Disposal). The SCADA system monitors rainfall and conditions in major pipelines and then adjusts in-line regulator gates and pump speeds when flows reach predetermined "set points." The automatic control of the regulator stations significantly reduces CSOs by maximizing storage during a storm and then conveying the flows to West Point for treatment when the storm subsides. When needed, the automatic controls can be overridden by experienced operators at the West Point main control center.

King County continually modifies the SCADA system to take into account advances in computer modeling, to incorporate more recent field data, and to reflect modifications to the wastewater

⁴ These programs are required by the U.S. Environmental Protection Agency's (EPA's) Nine Minimum Controls. (See the discussion on the Nine Minimum Controls later in this chapter.)

system. For example, in 1992, storage levels behind regulator stations were raised to improve the capture of CSOs. Currently, a modified CSO drawdown strategy is being tested at the Interbay Pump Station that will provide additional storage capacity in the upper portion of the interceptor.

Over the last couple of years, SCADA system hardware and software at the West Point Treatment Plant have been replaced with a new system to bolster the reliability of monitoring and control of offsite regulator and pump stations. The new hardware includes enough capacity to install and run an optimization program, called Predictive Control, that can monitor rainfall and conditions in the major trunks and interceptors, predict inflows to the sewer system, and optimize the regulation of flow through the regulators to further minimize CSOs. Development and calibration of the Predictive Control model will occur in 2005–2007; a new updated control program is expected in 2007–2009. These and other improvements could reduce CSO volumes by as much as 150 million gallons per year.

3.2.3 CSO Control Projects

To reduce the discharge of CSOs into area water bodies, King County has completed sewer separation projects and has constructed storage, conveyance, and treatment facilities.

New storage tunnels hold combined sewage until a rainstorm subsides and capacity opens up in the conveyance and treatment system. Then as much flow as possible is sent to the regional plants for secondary treatment. Flows that cannot be stored either receive primary treatment (physical settling of solids, disinfection, and dechlorination) at CSO treatment facilities or are discharged untreated to area water bodies. CSO treatment facilities are built to directly serve the areas where they are located; they operate only during heavy rainfall. King County CSO treatment facilities include the Alki and Carkeek CSO Treatment Plants and two facilities completed in May 2005—the Mercer/Elliott West and the Henderson/Norfolk CSO control systems.

As described in Chapter 2, the RWSP identified 21 CSO control projects scheduled for completion by 2030. These projects will provide steady progress toward bringing King County into compliance with Ecology regulations for control of CSOs. The projects were prioritized in the RWSP based on protection of human health, endangered species, and the environment. New information available since the RWSP supports these priorities. The next projects to be implemented—Barton, Murray, North Beach, and Magnolia—are the Puget Sound beach projects at locations having the highest recreational uses. These beach projects are scheduled for completion in 2012. Updated modeling will be done for these projects to provide information needed for predesign in mid 2006. Low-interest State Revolving Fund (SRF) loans from Ecology have been awarded to fund the bulk of predesign for Murray, Barton, and North Beach; Ecology has encouraged King County to resubmit its application for Magnolia during the next loan cycle. Monitoring indicates that the SW Alaska Street CSO is not needed because the location is already controlled.

Completed CSO control projects are shown in Table 3-2. Projects done primarily for other reasons, but with CSO control benefits, are shown in Table 3-3. The more significant projects shown in the table are discussed in the sections that follow.

Table 3-2. Completed CSO Control Projects

Project	Description	Year Completed	Status
Ft. Lawton Tunnel	Parallel tunnel to West Point to provide greater transfer capacity.	1991	Completed.
SCADA (CATAD) System Improvements	Improvements to the system that controls flows and maximizes storage in pipelines.	Ongoing	Recent improvements will be completed in 2009 with completion of the upgrade of the Interbay Pump Station and implementation of upgraded computer control. Maintenance and improvement will be ongoing.
Hanford/Bayview/Lander Separation & Storage	Partial separation of the Lander and Hanford basins, and reactivation of Bayview Tunnel. (Joint project with the City of Seattle.)	1992	Remaining control will occur under RWSP projects in 2017 (Hanford), 2019 (Lander), and 2026 (Hanford at Rainier). Lander stormwater management is ongoing.
Carkeek Transfer/CSO Treatment	Transfer to West Point of flows up to 9.2 mgd from the Carkeek drainage basin. Treatment of flows above 9.2 mgd at the Carkeek CSO Plant.	Online in 1994; upgrades in 2005; dechlorination began in 2006	Because the Carkeek plant was receiving more flow than anticipated, pumping capacity at the Carkeek Pump Station was upgraded from 8.4 to 9.2 mgd in 2005 to send more flows to West Point. Dechlorination was started in 2006 to comply with 2005 NPDES permit modifications.
University Regulator/Densmore Drain	Separation of Densmore & I-5 stormwater, as well as Green Lake drainage.	1994	Remaining control will occur under an RWSP project in 2015. Densmore stormwater management is ongoing.
Kingdome Industrial Area Storage & Separation	Installation in 1994 of a storage pipeline in conjunction with Seattle and WSDOT street projects. In 1999, the Public Facilities District (PFD) completed separation between Alaska Way and 3 rd Ave. in conjunction with Safeco Field construction.	1994; 1999	Remaining control will occur in 2026 under an RWSP project.
Harbor Pipeline	Installation of a pipeline that conveys excess flow from the Harbor regulator to the West Seattle Tunnel for storage.	1996; activated in 2000/01	

Project	Description	Year Completed	Status
Alki Transfer/CSO Treatment	Transfer to West Point of flows up to 18.9 mgd from the Alki drainage basin via the West Seattle Tunnel. Treatment of flows above 18.9 at the Alki CSO plant.	1998; dechlorination began in 2006	Additional CSO plant modifications were completed in 1999. Dechlorination was started in 2006 to comply with 2005 NPDES permit modifications.
63 rd Ave. Pump Station	Diversion of excess flow to the West Seattle Tunnel or Alki CSO Plant.	1998	
Denny Way/Lake Union (completed system is called Mercer/Elliott West)	Storage and primary treatment of Lake Union flows in the Mercer Tunnel, with screening, disinfection, and discharge at Elliott West.	2005	Construction of major facilities was completed; startup is under way.
Henderson/MLK/Norfolk (completed system is called Henderson/Norfolk)	Storage, primary treatment, and disinfection of Henderson and MLK flows in the Henderson Tunnel; transfer of flows to secondary treatment plants; discharge of excess treated CSOs at Norfolk.	2005	Construction was completed; startup is under way.

Table 3-3. Completed Associated Projects

Project	Description	Completion	Status
Renton Sludge Force Main Decommissioning	Before South plant developed solids management capability, sludge was pumped via the Elliott Bay Interceptor to West Point for processing; decommissioning of the force main may have decreased solids discharge from the Interbay Pump Station at the Denny CSO.	1988	Completed.
Ballinger and York Pump Stations	Construction of two new pump stations so that flows can be diverted to and from the West Point collection system. Flows are currently diverted away from West Point during the wet season.	1992 (York Pump Station); 1993 (Ballinger Pump Station)	Completed.
West Point Treatment Plant Expansion	Increase in plant hydraulic capacity from 325 mgd to 440 mgd to enable conveyance and treatment	1995	Completed.

Project	Description	Completion	Status
	of more flow from the combined sewer system.		
Allentown Diversion/Southern Transfer	Designed to offset addition of Alki flows to the Elliott Bay Interceptor. Side-benefit of significant volume reduction at Norfolk.	1995	Completed.
North Creek Pump Station	Diverts flow to the South plant collection system during wet weather.	1999	Completed.

3.2.3.1 Upgrade to Secondary Treatment at West Point Plant

In 1995, the West Point Treatment Plant was upgraded to provide secondary treatment of wastewater flows. The plant has enough capacity to provide treatment of about 140 mgd of CSO flows beyond the level required for CSO treatment. The CSO flows receive primary treatment and then are mixed with secondary effluent before disinfection, dechlorination, and discharge from the deep marine outfall. The resulting effluent meets secondary effluent quality limits; during the wet season, however, a small allowance is made in the percent removal limits for biological oxygen demand and total suspended solids.⁵ A total of 352 million gallons of captured CSOs received this kind of treatment in 2004–2005.

3.2.3.2 Carkeek and Alki CSO Treatment Plants

When it was originally constructed, the Carkeek CSO Treatment Plant was a primary treatment plant serving the local area. When the Clean Water Act of 1972 required agencies to provide secondary treatment of wastewater, Metro decided to transfer the base local flows to West Point for secondary treatment and to redesign the Carkeek plant to provide CSO treatment of excess combined flows from the service area. The transfer and conversion were completed in 1994.

During its first NPDES permit cycle of operation, the Carkeek plant exceeded the frequency and volume limits set in the permit. The Carkeek Overflow Reduction Study, completed in 2003, found that the local service area was sending more flow to Carkeek than was expected when the plant was designed. In 2005, the pumping capacity of the Carkeek Pump Station was upgraded from 8.4 to 9.2 mgd to increase the volume of flows conveyed to West Point for secondary treatment and discharge. Ecology modified the NPDES permit limits to reflect these new conditions. Flows in excess of 9.2 mgd are stored at Carkeek. Stored flows that cannot be sent to West Point receive treatment, disinfection, and dechlorination before being discharged to Puget Sound. In 2004–2005, the Carkeek plant discharged CSO flows four times; the total volume was 4.04 million gallons.

Similar to Carkeek, the Alki CSO Treatment Plant originally provided primary treatment to local flows. Since 1998, base flows are transferred to West Point to meet secondary requirements and

⁵ From November through May, 80 percent removal is allowed rather than the 85 percent required during the dry season.

the Alki plant provides CSO treatment to excess combined flows. While the system was designed to discharge treated CSO flows from the Alki plant approximately 29 times per year, the Alki plant operates on average only 2 times per year. The West Seattle Tunnel, completed in 1998, has allowed much of the flow to go to West Point via the Elliott Bay Interceptor. This increased transfer of Alki area flows to West Point has resulted in occasional permit compliance problems. The remaining two events per year occur under the largest storms, and so are the most dilute and difficult to treat. Discussions with Ecology are scheduled to begin soon.

3.2.3.3 Mercer/Elliott West CSO Control System

The Mercer/Elliott West CSO control project was a joint effort of King County and the City of Seattle to control CSOs into Lake Union and Elliott Bay. After 12 years of planning and more than 4 years of construction, the project was completed in May 2005. The completed system includes several elements:

- The Mercer Street Tunnel, a 14.7-foot-diameter storage and treatment tunnel running more than a mile under Mercer Street through the base of Queen Anne Hill.
- The Elliott West CSO Control Facility for transferring flows to West Point or for additional treatment of flows that exceed the capacity of the tunnel.
- One new outfall extending up to 340 feet offshore and 60 feet deep in Elliott Bay; a second short outfall for flows in excess of the capacity of the Mercer/Elliott West system (expected to discharge no more than once per year on average).

During small and moderate storms, the new system stores flows in the Mercer Street Tunnel. After a storm subsides and when capacity is available, the system sends the flows to the West Point Treatment Plant for treatment. During major storms, when the volume of flow exceeds the storage capacity in the tunnel, the excess flows, having received primary settling in the tunnel, are conveyed to the Elliott West CSO Control Facility, where they are screened, disinfected, and dechlorinated prior to discharge into Elliott Bay. When capacity is available again, the flows and settled solids in the tunnel drain to West Point for further treatment.

The new facilities will reduce both the volume and the frequency of untreated overflows into Lake Union and Elliott Bay. It is predicted that the number of untreated CSO discharges from the Denny Way Regulator into Elliott Bay will be reduced from a previous average of 32 per year to 1 per year,⁶ and the number of treated CSO discharges will be approximately 14 to 20 per year. This significant reduction in untreated CSO frequency and volume will likely result in immediate and long-term improvements in water quality in Lake Union, Elliott Bay, and Puget Sound.

⁶ In the facilities plan for this project, the average number of CSOs was estimated at 50 per year. The different number shown in this chapter (32 per year) reflects a change in modeling approach and inter-event interval definition since the preparation of the facilities plan.

3.2.3.4 Henderson/Norfolk CSO Control System

The Henderson/Norfolk CSO control project, also completed in May 2005, is similar to the Mercer/Elliott West system. It will reduce the discharge of untreated combined sewage to Lake Washington and the Duwamish River. The completed system includes several elements:

- The Henderson Tunnel, a 14.7-foot-diameter storage and treatment tunnel running two-thirds of a mile under 42nd Avenue South on Beacon Hill.
- More than 2 miles of tunnels and pipelines under South Henderson Street and South Norfolk Street from Lake Washington to the Duwamish River at the Norfolk CSO.
- Expansion of the pumping capacity of the Henderson Pump Station near Lake Washington from 7.5 to 20 mgd.

During storms, the new system stores excess flows in the Henderson Tunnel. After a storm subsides and when capacity is available, the system sends the flows to the South Treatment Plant for treatment. During major storms, when the volume of flow exceeds the storage capacity in the tunnel, the excess flows receive primary settling, screening, and chlorination and dechlorination in the tunnel, and then are conveyed to the Norfolk outfall, where they are discharged to the Duwamish River. When capacity is available again, the flows and settled solids in the tunnel drain to the South plant for further treatment.

The number of untreated CSO discharge events from the Henderson CSO to Lake Washington will be reduced from an average of 12 per year to less than 1 per year. Overflows from the Martin Luther King, Jr., CSO to Lake Washington will be reduced from an average of 16 per year to less than 1 per year. The number of untreated CSO discharge events from the Norfolk CSO to the Duwamish River will be reduced from an average of 20 per year to 1 per year; approximately 2 to 4 treated discharges will occur at Norfolk.⁷ The reduction in untreated CSO frequency and volume will likely result in immediate and long-term improvements to water quality in Lake Washington and the Duwamish River.

3.3 Implementation of EPA CSO Control Regulation

EPA's 1990 CSO Control Policy was codified as the Wet Weather Water Quality Act of 2000 (H.R. 4577, 33 U.D.C. 1342(q)). This act requires implementation of Nine Minimum Controls for CSOs and the development of long-term CSO control plans. The initiation of the CSO Control Policy in 1990 occurred well after the enactment of Washington State CSO regulations. At the time, King County was already implementing most of the policy elements and needed only to identify and document existing practices in order to comply with EPA's policy.

⁷ In the facilities plan for this project, the average numbers of CSOs at the Henderson, MLK, and Norfolk locations were estimated at 11, 15, and 20 per year, respectively. The different numbers shown in this chapter reflect a change in modeling approach and inter-event interval definition since the preparation of the facilities plan.

3.3.1 Nine Minimum Controls

EPA's Nine Minimum Controls were developed to provide early and relatively inexpensive actions to improve water quality without having to wait for completion of the more expensive capital projects. When they were published, the Nine Minimum Controls packaged and codified elements, including CSO-specific elements, contained in the operations and maintenance programs of well-run wastewater management programs. Most of them were already standard practice in the King County system.

Table 3-4 describes King County actions that implement the Nine Minimum Controls and supplemental actions that will be implemented to comply with the recent modification to West Point's NPDES permit.

3.3.2 Long-Term Control Plan

The requirements of the EPA Wet Weather Water Quality Act are similar to Washington State CSO regulations. Under both, compliance with the state Water Quality Standards (WAC 173-201A) must be achieved. However, King County may need to provide documentation of CSO control activities in a manner that meets EPA expectations. The state-mandated CSO control plan will be modified, as needed, so that the plan complies with both regulatory programs. The Wet Weather Water Quality Act is implemented through NPDES permits, and any additional changes in permit requirements will occur in the next NPDES permit for the West Point Treatment Plant, scheduled to occur in 2008.

Table 3-4. King County's Compliance with EPA's Nine Minimum Controls

Nine Minimum Controls	King County Compliance Effort
Control 1. Proper operation and regular maintenance programs for the sewer system and CSOs	King County regularly maintains CSO outfalls, regulator stations, and pump stations through the West Point Treatment Plant, South Treatment Plant, and collection system maintenance divisions. Proper facility operation is managed by West Point staff using the SCADA system. ^a Collection system staff inspect sewers on a specified schedule and perform corrective actions when deficiencies are found. Maintenance schedules and records of visits are available for inspection upon request.
Control 2. Maximize use of collection system for storage	The SCADA system manages regulator stations to maximize flows in interceptors and to store excess flows in large trunk sewers.
Control 3. Review and modification of pretreatment requirements to ensure that CSO impacts are minimized	King County's Industrial Waste Program issues permits that set limits on the chemical contents of industrial discharges. The program also includes monitoring and permit enforcement, education, and technical assistance to businesses on appropriate waste pretreatment and disposal techniques. King County also administers and helps fund the Local Hazardous Waste Management Program. Current water quality assessment and sediment management plan data indicate that there is no need for CSO-specific pretreatment program modifications.
Control 4. Maximization of flow to secondary treatment plant for treatment	The SCADA system is used to maximize flow to the West Point Treatment Plant by operation of regulator and pump stations. All analyses completed for CSO control project alternatives include varying the levels of storage and transfer to the secondary treatment plants.

Nine Minimum Controls	King County Compliance Effort
Control 5. Elimination of CSOs during dry weather	King County's maintenance and operation programs focus on preventing dry-weather overflows. Dry-weather overflows may occur as a result of equipment malfunction or loss of power. The conveyance system is monitored through the SCADA system, and corrective action is taken immediately if a problem occurs. Equipment problems are immediately reviewed, and repair or replacement activity is undertaken in a timely manner. Dry-weather overflows are reported to Ecology as sanitary sewer overflows.
Control 6. Control of solid and floatable materials in CSOs	City of Seattle street sweeping and catch basin maintenance limit introduction of floatable materials to sewers. Procedures to record observations of floatable materials are being revisited.
Control 7. Pollution prevention programs to reduce contaminants in CSOs	King County has implemented both the Industrial Waste Program and the Local Hazardous Waste Management Program to reduce discharge of chemicals and other substances that adversely impact the environment and the wastewater treatment process. These programs have received national recognition.
Control 8. Public notification program to ensure that public receives adequate notice of CSO events and impacts	<p>King County, the City of Seattle, and Public Health–Seattle and King County have undertaken a joint public outreach effort to inform the public about the location of CSOs, their actual occurrence, and the possible health or environmental impacts of CSOs. The outreach effort includes a CSO posting and public notification program. Signs have been posted near CSO outfalls stating, "WARNING: Possible Sewage Overflows During and Following Heavy Rain." The drawing on the signs warns people to not swim or fish at these outfalls during or following rainstorms.</p> <p>In addition, the outreach effort includes media releases and a brochure, fact sheet, Web site (www.metrokc.gov/health/hazard/cso.htm), and CSO information telephone number (206-205-1151) to answer health concerns about CSOs.</p> <p>The recently modified NPDES permit requires King County to conduct a study to determine the feasibility of providing more immediate notification of overflows, including the feasibility of providing a Web-based system. A draft report is due to Ecology by July 1, 2006; a final report is due by July 1, 2007. The City of Seattle's NPDES permit renewal contains a similar requirement. The County and the City will discuss the possibility of working together to produce a joint program, as they did for the original CSO Notification and Posting Program.</p>
Control 9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls	Under the 1988 CSO Plan, King County's sampling program (now complete) included collecting data for five CSO sites per year. The King County 1999 <i>CSO Water Quality Assessment</i> found that the majority of risks to people, wildlife, and aquatic life would not be reduced by removal of CSOs in the Duwamish River and Elliott Bay because most risk-related chemicals come from sources other than CSOs. King County may undertake additional sampling on completion of specific CSO control projects.

^a The supervisory control and data acquisition (SCADA) system controls the West Point Treatment Plant collection system. See the discussion of the SCADA system in this chapter.

CSO Control Program Review

In 1999, when it adopted the Regional Wastewater Services Plan (RWSP), the Metropolitan King County Council recognized that the RWSP was a complex and dynamic plan that would require regular review and updates. The Council specifically called for a review of the benefits of the CSO control program. No new CSO control projects were to be undertaken until after completion of the review.

To conduct the review of the CSO control program, King County staff have been gathering and assessing information over the last few years. The review has identified areas of efficiency and success, as well as areas where improvements could be made. These improvements are being implemented. The findings of this review will provide substantive information to the remaining planning for the 2008 CSO plan update, leading to further refinements of the control program and projects. WTD recognizes the value of this type of review and plans to conduct similar reviews on a regular basis ahead of control plan updates. The next review will occur in 2010.

This chapter describes the review process, its conclusions, and any remaining issues. It is organized according to the topics listed in the RWSP policy for the CSO control program review:

- Maximizing the use of existing CSO control facilities
- Identifying the public and environmental health benefits of continuing the CSO control program
- Ensuring that projects are in compliance with new regulatory requirements and objectives such as the Endangered Species Act and the Wastewater Habitat Conservation Plan
- Analyzing rate impacts
- Ensuring the program review will honor and be consistent with long-standing commitments
- Assessing public opinion
- Integrating the CSO control program with other water and sediment quality improvement programs for the region

4.1 Maximizing the Use of Existing CSO Control Facilities

In the Wet Weather Water Quality Act of 2000 (H.R. 4577, 33 U.D.C. 1342(q)), the U.S. Environmental Protection Agency (EPA) requires the implementation of Nine Minimum Controls to reduce CSOs (see Chapter 3). These controls emphasize methods, such as operational controls, that can be implemented faster than costly capital projects. These controls are included

in the County's NPDES permit for the West Point Treatment Plant. Three of the Nine Minimum Controls are relevant to maximizing the use of existing CSO control facilities:

- Implement proper operation and regular maintenance programs for the sewer system and CSOs
- Maximize use of collection system for storage
- Maximize flow to secondary treatment plant for treatment

These controls were used as the basis for the review of the use of CSO facilities. The review included physically inspecting each CSO facility and rain gauge to supplement ongoing inspection programs, reviewing monitoring data, and making improvements based on the inspections and review. The scope was then broadened to include topics such as control program organization, coordination, and communication as means to effective program implementation. The first step was to inventory roles and responsibilities within WTD that relate to these tasks. A workshop and follow-up meetings were held across the division not only to identify ways to maximize the use of existing facilities but also to improve the coordination framework and methodologies that implement the program. These meetings were followed by a survey of staff to identify their communication needs and various approaches to meet these needs.

To ensure that combined sewage receives the best treatment possible, the program strategy is to send as much flow as possible to regional treatment plants. CSO control facilities, such as storage or satellite treatment, are built to manage peak flows. As such, they operate as backup to the transfer of flows to regional treatment plants—operating only when flows cannot be managed immediately at regional plants. These CSO facilities may be used only a few times a year to achieve the regulatory control standard. The strategy is implemented in the following order: (1) direct transfer to a regional plant, (2) inline storage, followed by transfer to a regional plant, (3) offline storage in facilities such as tunnels or tanks, followed by transfer to a regional plant, and (4) satellite CSO treatment and discharge.

The remainder of this section discusses the inspections of CSO facilities and rain gauges and the review of monitoring data and CSO control status. Appendix C describes the approach and results of the staff inventory, workshop, and survey.

4.1.1 Inspections of CSO Facilities and Rain Gauges

As a part of the CSO program review, the outfall for each CSO facility was located and its coordinates were updated via global positioning system for input to the County's geographic information system (GIS). In addition, monitoring equipment was checked for proper functioning. These checks identified a few needed corrections, such as moving a flow monitor to another location. Corrections are completed or in progress.

Rain gauges provide information for both system operation and facilities planning. As a part of this review, all gauges were inspected and recalibrated and a system was put in place to provide

regular checks. Meetings were held between planning, offsite, and engineering staff to review set-points.¹ Discussions identified improvements to decision processes and changes to set-points.

The review of monitoring data (discussed in the next section) identified the need for additional improvements. In one location, reports of zero overflow were found to be the result of a lost data link in the software. In another location—the Montlake CSO—a recent trend of increased overflows led to an inspection of the Montlake siphon. The siphon was found to be about 75 percent obstructed, and a major cleaning was implemented. The identification of this unexpected obstruction prompted the scheduling of inspections of other siphons in the system. Subsequent inspection of the Ballard siphon identified significant concerns that require immediate repair or replacement. This work is under way. Normal inspections and data assessment would likely have identified these problems, but this review accelerated their correction.

4.1.2 Review of Monitoring Data and Status of CSO Control

Monitoring data were reviewed for any trends or changes. Data for the last 5 years indicate that the period had lower than average rainfall. As a result, the average annual CSO volume is about half that predicted by the model. More recent work done for this program review indicates that the model needs to be updated and recalibrated. This process is under way and should be complete in 2007.

King County’s CSO plan was based on the assumption that the City of Seattle had controlled most of its CSOs. However, since adoption of the RWSP, the City monitored all of its CSO locations and found that several are not controlled. In 2001, the City amended its plan to control these remaining CSOs by storing and then transferring these flows to the King County conveyance system for transport and treatment at regional plants. The City has committed to building its storage facilities large enough so that City flows do not increase overflows at King County CSO locations. The City will need to work with the County to assess the impacts of its projects on downstream County facilities and the capacity of the West Point Treatment Plant to accept City flows for treatment. This will be a challenging coordination as both agencies are now competing for the same remaining system capacity for their captured CSO flows.

4.2 Identifying the Public and Environmental Health Benefits of Continuing the CSO Control Program

For this CSO control program review, WTD took a fresh look at existing information, reviewed new information, and completed studies to assess—both quantitatively and qualitatively—the health benefits to the public, environment, and endangered species of completing the program. The assessment drew from studies describing existing environmental conditions and predicted

¹ Set-points are flow levels at which controls adjust pump speeds and operate regulator and outfall gates to store or discharge flows.

conditions at the completion of the program. It built on the findings of the County's 1998 *Water Quality Assessment of the Duwamish River and Elliott Bay* (WQA) and 1999 *Sediment Management Plan*—both done in support of the RWSP—and on annual water quality reports.

Studies conducted to better understand how to protect fish species listed as threatened under the Endangered Species Act (ESA) provided insight into the life stages of these species and the effects of degraded water, sediment, and habitat on their survival. WTD helped to generate some of this information through its participation in Watershed Resource Inventory Areas (WRIA) groups in King County, initiation of a Habitat Conservation Plan, and review of CSO occurrence in relation to presence of juvenile chinook salmon. Also reviewed were published findings from the studies being conducted in support of contaminated sediment cleanup in the Duwamish River, which present some of the most current science available that is relevant to CSO control planning. Finally, the most recent science on climate change and sea level rise in the Puget Sound was reviewed for issues that may affect CSO planning.

This section summarizes the implications of this information for King County's CSO control program and then further describes the information. Greater detail is provided in Appendix C.

4.2.1 Summary of Public and Environmental Health Information and its Relation to CSO Control

Knowledge from recent scientific studies does not warrant any change in course. The findings from the review reinforce the direction of the RWSP CSO control plan. King County is committed to controlling all remaining CSO sites by 2030. The RWSP priorities to protect human health, endangered species, and the environment remain valid. Under the RWSP schedule, design will begin in mid 2006 on projects with the greatest benefit to human health protection—the Puget Sound Beach projects. Control projects will continue to be designed to transfer as much captured CSO flow as possible to regional plants for secondary treatment.

The studies underscore the finding of the 1998 WQA that the primary benefit of the planned CSO control will be the reduction of risks to humans from pathogens in the area near each CSO. The improvement from these reductions, however, may be barely perceptible on a watershed level because CSO discharges contribute pathogens for only short periods while other sources, such as upstream stormwater agriculture run-off or leaking septic systems, are contributing high levels of pathogens on an ongoing basis.

Possible effects from bioaccumulating and endocrine-disrupting chemicals (EDCs) are being documented in the scientific literature.² The literature seems to indicate that the length and frequency of exposure in the water column are significant factors related to potential effect. However, risks resulting from CSOs appear to be low because the chemical concentrations in the water column are low and exposure is brief and infrequent. It is expected that international

² In bioaccumulation, low concentrations of chemicals build up in the food web to levels resulting in tissue concentrations that are harmful to aquatic organisms or to those that prey on them, including humans. Endocrine-disrupting chemicals mimic, inhibit, or alter the hormonal regulation of animal systems, such as the immune, reproductive, or nervous system or other parts of the endocrine system.

studies will continue until definitive answers are known and regulations instituted. King County will support research through organizations such as the Water Environment Research Foundation, will monitor evolving knowledge, will emphasize pollution prevention programs, and will explore new ways to test for EDCs using better low-level detection methods at its environmental lab.

Many recent studies have focused on the Duwamish River because of sediment cleanup projects in the area. With regard to protection of human health, information generated from the Lower Duwamish Waterway Superfund process is increasing our understanding of fish consumption and human health risk. Studies under way may shed more light on whether these risks result from historical sediment contamination or from an ongoing contribution from CSOs and other sources. If an ongoing human health risk from CSOs in the Duwamish River is identified, King County may consider changes in the control schedule to accelerate CSO control projects at those locations. Determining remaining relative priorities of projects scheduled for completion after the Puget Sound beach projects will be difficult because comparable information is not as available for other areas where CSOs occur, such as Elliott Bay, the Ship Canal, and the East and West Waterways of the Duwamish River.

With regard to protection of salmon, the perception that CSOs are harmful must consider that the area with the greatest volume of overflow—the Duwamish River—has the healthiest run in terms of numbers of both hatchery and naturally spawning fish. At this time, protection of endangered salmon does not appear to be enhanced by changes in the CSO control schedule that would prioritize the Duwamish over other locations.

Much uncertainty still remains in the available scientific knowledge and its applicability to CSO control. In the face of these uncertainties, WTD should continue to place emphasis on source control for pollutants of concern, on CSO control alternatives that promote storage and transport to regional plants for secondary treatment, and on the cleanup of areas with contaminated sediment. WTD will continue to monitor scientific studies, conduct its own studies when needed, and track water quality trends. Any recommended schedule changes to address new scientific information will be available for public discussion ahead of the next CSO control program review in 2010; any information that is available earlier will be incorporated into the 2008 CSO control plan update.

4.2.2 Description of Recent Studies and Activities Relating to Public and Environmental Health

The following sections describe ESA-related studies, sediment management activities and studies near CSO locations, and recent information on climate change and sea-level rise.

4.2.2.1 Studies in Support of Protection of Threatened Species Under ESA

Since the listing of bull trout and chinook salmon as threatened species under the ESA, King County has participated in or has taken the lead on studies to better understand the factors affecting the health of these species and to develop ways to protect them. WTD supports the

multi-jurisdictional watershed planning efforts for the watersheds in King County. The Salmon Conservation Plans developed for the watersheds recommend actions in the lower reaches that should be considered in CSO planning.

Also in response to the ESA listings, WTD voluntarily began development of a Habitat Conservation Plan (HCP) for all its activities that could have an effect on these species. Although WTD ultimately decided that the commitment of resources required to match the uncertainty level was too substantial to continue the HCP process, the studies done on persistent bioaccumulative toxins and EDCs in support of the HCP provided valuable direction for WTD activities and future studies.

Finally, as part of this CSO program review, WTD conducted an assessment of the presence and abundance of juvenile chinook salmon in comparison with average exposure to CSOs. The findings of the assessment contribute to the discussion of priorities for CSO control.

The following sections describe this information in more detail.

Presence of Threatened Species in the Watersheds

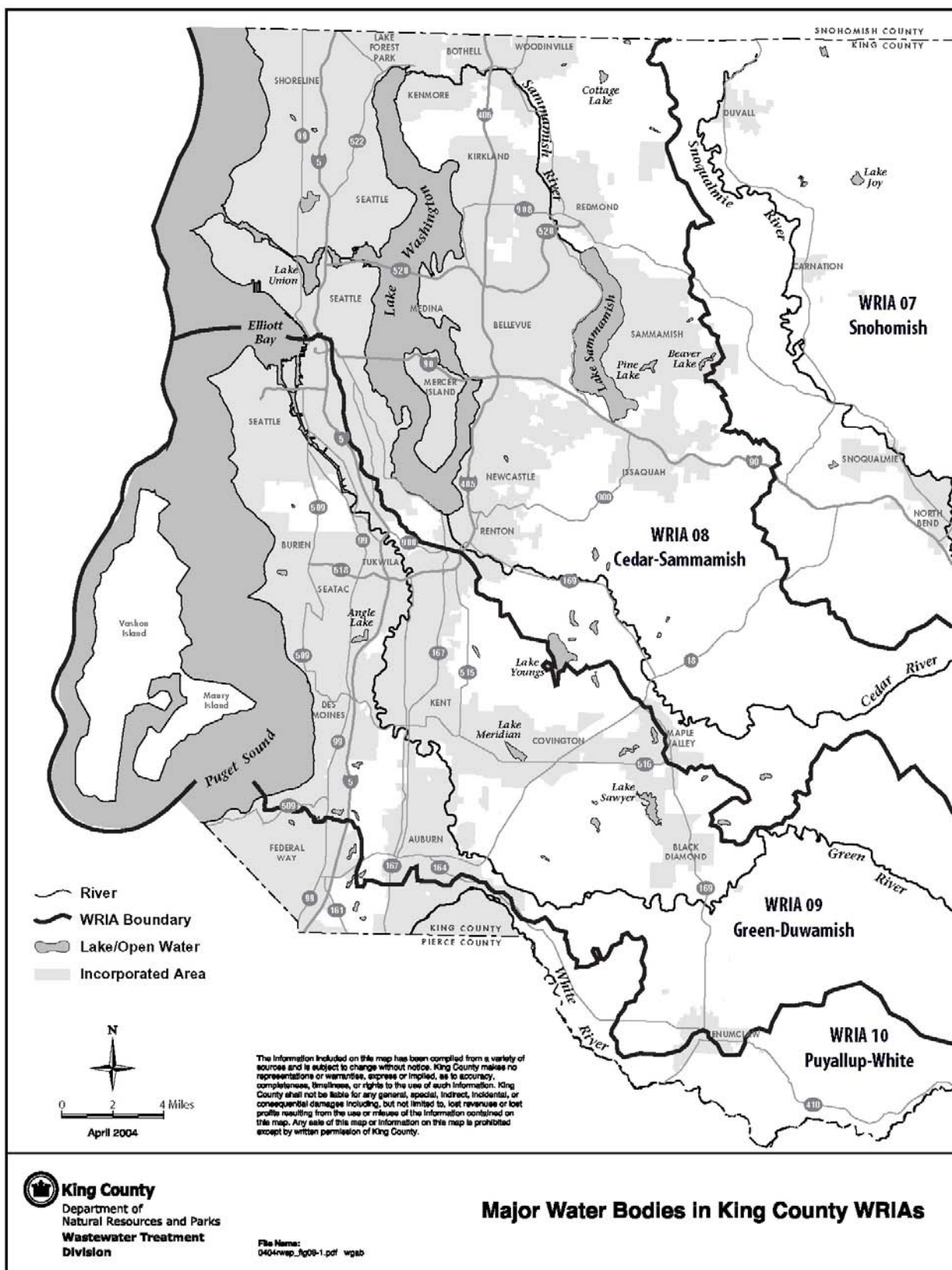
CSOs occur in the lower reaches of each of the two primary watersheds in King County's wastewater service area (Figure 4-1). These watersheds—called Water Resource Inventory Areas (WRIAs)—are the Lake Washington/Cedar/Sammamish watershed (WRIA 8) and the Green/Duwamish and Central Puget Sound watershed (WRIA 9).

In WRIA 8, King County CSOs in Lake Washington are controlled but uncontrolled CSOs remain in the Ship Canal and the nearshore area near Carkeek Park. Three chinook salmon populations migrate in and out of the watershed through the lakes, Ship Canal, and Locks. Juveniles rear in the marine nearshore areas of Puget Sound before heading into the ocean. Studies indicate that all three populations are at extremely high risk of extinction. The Cedar River population is at highest risk, followed by North Lake Washington and then Issaquah populations.³

In WRIA 9, King County CSOs are located in the lower Duwamish River from the turning basin to the mouth, in Elliott Bay, and along the Alki shoreline. The Green/Duwamish River system has not experienced the same decline in chinook salmon as has occurred in other systems. Currently, the system supports an average yearly total run (fish returning to the river and those caught in fisheries) of about 41,000 adult chinook salmon. Overall, Green River chinook are resilient and have survived the effects of large-scale production of hatchery fish, high harvest rates, and habitat alteration (Figure 4-2).⁴

³ September 2002. *Salmon and Steelhead Limiting Factors Report for the Cedar Sammamish Basin (Water Resource Inventory Area 8)*.

⁴ December 2000. *WRIA 9 Habitat Limiting Factors and Reconnaissance Assessment for Salmon Habitat in the Green/Duwamish and Central Puget Sound Watershed*.



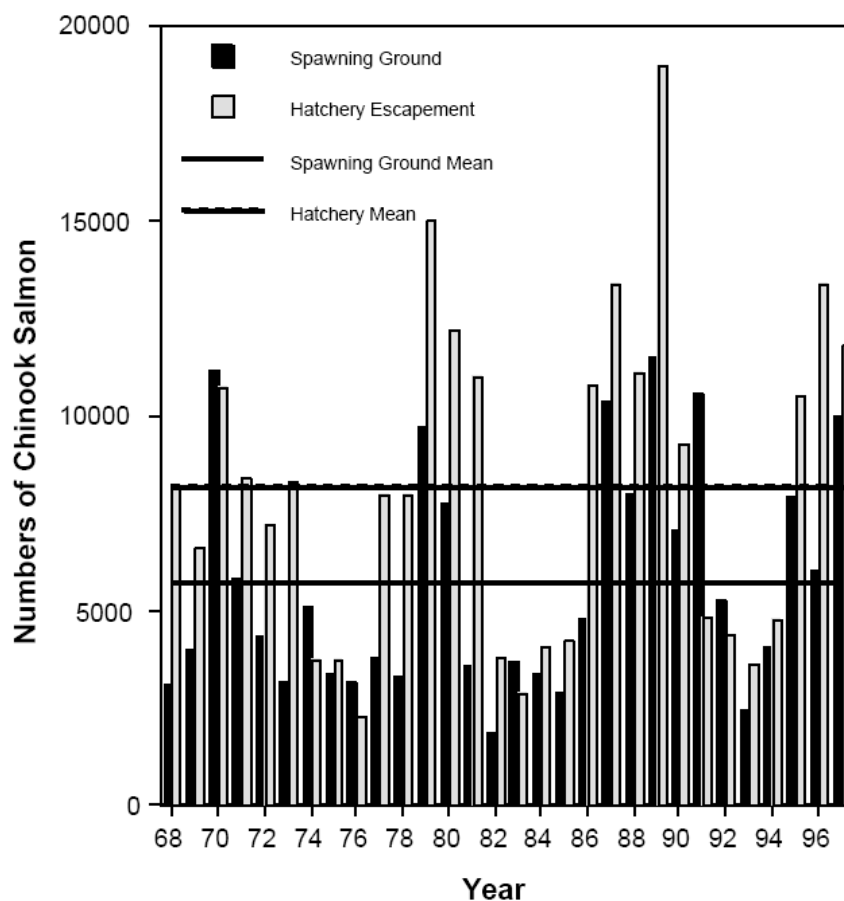


Figure 3. Time series of chinook salmon returning to the spawning grounds and to the hatcheries, 1968-1997. Spawning ground estimates include an unknown number of stray hatchery salmon. Mean values are shown. Data source: WDFW 1998.

Figure 4-2. Time Series of Green River Chinook Salmon Returning to the Spawning Grounds and to the Hatcheries, 1968–1997⁵

Given the varied life history strategies of bull trout and the limited information regarding the species, the U.S. Fish and Wildlife Service (USFWS) assumes the presence of bull trout everywhere in their historical range unless proven otherwise. Bull trout are likely to occur in the same water bodies, except for Lake Washington, as outmigrating juvenile chinook (which they prey on).

⁵ Source for Figure 4-2: December 2000, *WRIA 9 Habitat Limiting Factors and Reconnaissance Assessment for Salmon Habitat in the Green/Duwamish and Central Puget Sound Watershed*.

Presence of Chinook Compared to a Water Body's Exposure to CSOs

As part of this CSO program review, the presence and abundance of juvenile chinook salmon were compared with average exposure to CSOs in the Duwamish River and other water bodies where CSOs occur. The previous 5 years of discharge frequencies and volumes were graphed by month and then superimposed on a graph showing the presence and relative abundance of chinook. In general, the majority of juvenile chinook salmon are present during periods of the fewest discharges and the smallest volumes. This relationship is illustrated in the graph for the Duwamish River (Figure 4-3).

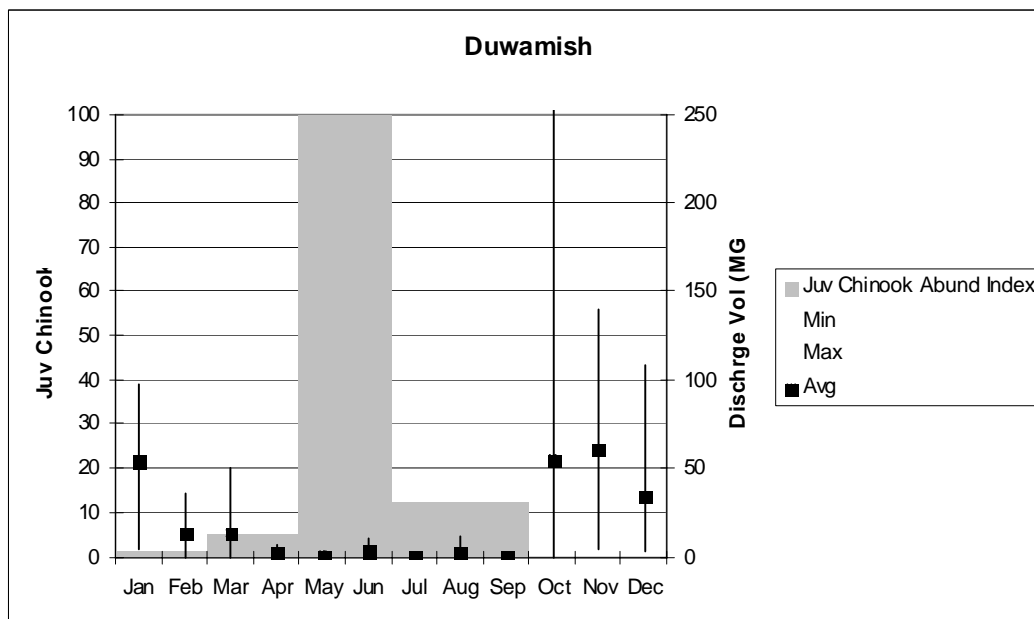


Figure 4-3. Presence of Duwamish River Chinook During CSO Discharge—Monthly Average Volume, 1999–2004

Given the finding that most juvenile chinook are near CSO outfalls when very little CSO discharge activity occurs and given that chemicals in CSOs are diluted through mixing, it was concluded that CSO discharges present little measurable harm to juvenile chinook. Additionally, because the essence of an ESA-based evaluation is a comparison between existing and future conditions, implementation of the CSO control plan will show a consistent improvement in habitat quality over time.

Salmon Conservation Plans: Strategies for Improving Habitat

A Salmon Conservation Plan was published for WRIA 8 in July 2005 and for WRIA 9 in August 2005. The plans describe long-term habitat conservation and recovery actions in WRIs 8 and 9 that take an ecological approach but concentrate on the needs of the ESA-listed species of

chinook salmon and bull trout. They include strategies, policies, and recommended projects to address factors that limit salmon habitat in the watersheds.⁶

Both WRIA plans recommend actions in the lower reaches of the watersheds that should be considered in CSO planning. One of the many recommended actions is to increase efforts to protect sediment and water quality, especially near commercial and industrial areas where there is the potential for fuel spills, discharge of pollutants, and degraded stormwater quality. While CSOs were not considered as a major concern in the plans, there is the perception that CSOs contribute to the degradation of water and sediment quality in salmon habitat. Associated with this perception is a larger concern about impacts from stormwater.

Habitat quality in the transitional areas of the estuaries is a priority. The WRIA 8 plan recommends the creation of pocket estuaries in the Ship Canal near the Hiram M. Chittenden Locks in order to increase the estuary area transition zone; the WRIA 9 plan recommends enlargement of the Duwamish estuarine transition zone habitat by expanding the shallow water and slow water areas. The WRIA 9 plan specifically recommends that area projects be leveraged to create improved habitat. Future CSO control projects may be assessed as opportunities to make needed habitat improvements.

Potential for Secondary Effluent to Contribute to Chemicals in the Puget Sound Food Web

The listing of bull trout and chinook salmon as threatened under the ESA prompted WTD to undertake the creation of a Habitat Conservation Plan (HCP) for all WTD activities that have the potential to impact these species. The HCP was proposed as a voluntary, two-phased, 40-year agreement with NOAA Fisheries and USFWS (the Services) that would outline WTD's efforts to protect threatened and endangered species while carrying on its wastewater management activities.⁷ The HCP effort was stopped in April 2005, after completion of Phase I, because the uncertainties uncovered were so large that the commitment of resources required to match the uncertainty level was deemed unacceptable. WTD chose, instead, to seek individual ESA consultations for projects with a federal link.

Before the HCP process was halted, the process produced valuable information that was reviewed for its applicability to CSO control. In one study, available data were reviewed to identify the types of chemicals that are bioaccumulating in the Puget Sound food web and to assess the potential for King County secondary treatment plant effluent discharges to contribute to this bioaccumulation. The study identified some persistent bioaccumulative toxins (PBTs) that are accumulating in the food web. Compared to other sources, WTD secondary effluent does not appear to be a significant contributor of these chemicals. There were not enough data to determine the effluent's contribution to mercury accumulations. As a precaution, WTD adopted

⁶ These habitat-limiting factors were documented in the Washington Conservation Commission's December 2000 *Habitat Limiting Factors and Reconnaissance Assessment Report for the Green/Duwamish and Central Puget Sound Watersheds (Water Resource Inventory Area 9)* and September 2002 *Salmon and Steelhead Limiting Factors Report for the Cedar Sammamish Basin (Water Resource Inventory Area 8)*.

⁷ NOAA = National Oceanic and Atmospheric Administration.

specific rules to limit mercury discharges by local area dentists, the greatest known source of mercury, into the wastewater collection system.

In addition, current scientific literature on endocrine disrupting chemicals (EDCs) was reviewed for the presence of these chemicals in wastewater effluents and their effects on aquatic species. There is evidence linking exposure to EDCs with effects on aquatic organisms. In general, however, the review concluded that there is inadequate knowledge of which chemicals exert endocrine disrupting effects, the biological and ecological significance of these effects, and their mechanistic bases.

The information from these studies is not directly applicable to CSOs because secondary treatment removes a portion of these chemicals from the wastewater stream; however, it does reinforce the value of continuing to maximize the amount of CSO flow that is sent to regional plants for treatment. It appears that the risks to the food web resulting from CSOs appear to be low. The chemical concentrations in CSOs are low and exposure is brief and infrequent. Studies will continue until definitive answers are known and regulations instituted.

4.2.2.2 Sediment Management and CSO Control

In recognition that management of contaminated sediments was emerging as an important environmental issue with implications for CSO control, the RWSP called for the development of a sediment management plan (SMP). The SMP was completed in 1999. It highlights the need to learn more about CSOs as possible current and historical contributors to contamination and to address sediment quality issues near CSO discharges and treatment plant outfalls. Recommended remediation projects are described in Appendix C.

Since completion of the SMP, King County is coordinating its sediment management efforts in the Duwamish River with two federal Superfund projects: the Harbor Island and the Lower Duwamish Waterway projects. Superfund is a highly structured and visible approach to managing sediment contamination. Because the process can impose projects and schedules that may not coincide with existing plans, schedules, and budgets, it is in WTD's interests to participate in decisions as early as possible.

King County's participation in the Harbor Island Superfund project began recently after the site was extended across the East Waterway of the Duwamish River to include the Port of Seattle's dredging project near the County's Lander and Hanford CSOs. King County will participate in the current East Waterway Superfund process and incorporate the remediations near the Lander and Hanford CSO sites into the larger response. In December 2000, King County, the Port of Seattle, the City of Seattle, and Boeing entered into an Administrative Order on Consent with EPA and the Washington State Department of Ecology (Ecology) for the Lower Duwamish Waterway (LDW) Superfund site. The County, City, Port, and Boeing voluntarily became involved early in the process before the site was listed under Superfund. Because of this early involvement, these entities are being allowed to undertake the basic work for the initial remedial investigation and feasibility study (RI/FS).

Although they do not relate directly to CSO control, the RI/FS studies do represent state-of-the-art knowledge about aspects of environmental and human health related to the Duwamish River

where many County CSOs occur. Phase 1 of the RI examined existing data on the risks to human health and the environment from sediment-associated chemicals in the LDW. The risk estimates were high enough to support moving forward with early action remediations. Two of the seven early action sites were near King County CSOs: Norfolk and Diagonal/Duwamish. Sediment near the Norfolk site had already been remediated in 1999; remediation of the Diagonal/Duwamish sediment was completed in 2004. Both projects were completed by King County, the City of Seattle, and the Elliott Bay/Duwamish Restoration Program (EBDRP).⁸ Phase 2, scheduled for completion in 2007, will fill the data gaps identified in Phase 1 and will estimate risks that remain after completion of early remedial actions. Phase 2 findings may have implications for CSO control planning.

Preliminary Phase 2 RI findings point in directions that the CSO control program will need to consider in the future. Although fish exposure projections do not warrant alteration of the CSO control plan at this time, emerging information will need to be followed closely. Recent EPA guidance for the Phase 2 human health risk assessment requires the use of fish consumption studies developed by local tribes. The much higher consumption rates will increase the estimated risks to human health. Preliminary Phase 2 results also suggest that current sediment quality targets for human health may not be adequately protective and may need to be reviewed. While there is no direct link to CSOs as a cause at this time, the increased attention and concern may influence control and schedule decisions.

Five years of post-remediation monitoring at the Norfolk site did not detect sediment recontamination. One sample in the last year showed unexpected contamination. So far, no link between this contamination and ongoing CSO discharges has been found. One year of monitoring at the Diagonal/Duwamish site has found that PCB concentrations are approaching the Sediment Quality Standards in the cleanup area and that phthalates have significantly increased in the sediment cap. Phthalates come from a variety of sources, perhaps in low levels that add up across many inputs.⁹ They are very difficult to control. If the trend cannot be reversed, concentrations in the cap could reach pre-cleanup levels. These findings may prompt considerations regarding the acceleration of CSO control; however, discerning and remedying the causes of recontamination will almost certainly prove to be more complex than simply controlling CSOs. Phthalate removal efficiency will be included in the pilot tests of promising CSO treatment technologies that will begin in 2006. (See the section in this chapter on “Analyzing Rate Impacts.”) Considerable discussion is occurring on this topic, and progress will be reported in the 2008 CSO plan update and 2010 CSO program review.

See Appendix C for additional detail on sediment management activities and studies.

4.2.2.3 Climate Change, Sea-Level Rise, and CSO Control

On October 27, 2005, King County Executive Ron Sims called together experts from across the country in a conference to discuss the latest information on global warming and climate change

⁸ The Elliott Bay/Duwamish Restoration Program administers projects funded under a 1990 settlement of litigation by the National Oceanic and Atmospheric Administration (NOAA) for natural resource damages from Seattle and King County CSOs and storm drains.

⁹ Inputs may include stormwater (via vehicular traffic), wastewater (via everyday products), and air deposition.

and to begin a conversation on their implications to providers of public services in the Pacific Northwest. Despite differing opinions on the details and climate models, there is broad scientific consensus that climate change is occurring; that human actions, especially the creation of greenhouse gases by burning fossil fuels, are contributing to these changes; and that steps need to be taken to both prepare for the expected effects of climate change and to possibly prevent them from worsening.

Sea-level rise is an important impact of climate change. Melting of the polar caps, increased river flow, and disruption of climate patterns such as the El Niño will raise sea level and increase the severity of storms and storm surges in parts of the Northwest coast. Low-lying areas are already at risk from projected average sea-level rise and are at even greater risk from average sea-level rise combined with storm waves, accelerated erosion at the base of bluffs and along the coast, and shrinking wetlands.

Compounding sea-level rise are geological forces related to the uplift or subsidence (sinking) of the land surface as tectonic plates converge (move toward or under one another). On the Washington coast, uplift may offset sea-level rise caused by climate change. The southern portion of Puget Sound, on the other hand, is sinking at up to 0.08 inch per year, or about an inch every 12 years. As a result of this subsidence, risks of sea-level rise are greatest in southern Puget Sound. A rise of 12 to 32 inches over a 75-year period is projected for Puget Sound.

WTD will monitor the growing information on climate change and sea-level rise. The design of new CSO control facilities or of modifications to existing facilities will consider climate impacts and sea-level change anticipated during the life of the facility. Possible accommodations could include increased sizing, higher facility elevations with respect to nearby water bodies, increased pumping, and enhanced flood and storm surge protections. Decisions as to when to implement these design features will be made based on when it would be most cost-effective to do so while still meeting the need.

Appendix C provides more detail on climate change and sea-level rise.

4.3 Ensuring that Projects Are in Compliance with New Regulatory Requirements and Objectives Such as the Endangered Species Act and the Wastewater Habitat Conservation Plan

King County has a strong history of compliance with regulations regarding its CSO discharges—both treated and untreated. The County also responds quickly to changes in regulations and even works to anticipate these changes.

WTD's CSO treatment facilities meet the NPDES discharge limits with few exceptions. The CSO control plan laid out in the RWSP was devised to ensure that the County continues to make

steady progress in meeting Ecology's CSO control standard of an average of one untreated CSO discharge per year at each CSO location by 2030.

The design of CSO control facilities must consider not only current regulatory requirements but also possible changes in the requirements in the next 5 to 10 years. Being proactive allows the County to begin conducting studies and modifying projects and programs in advance. In that way, programs and projects can be budgeted to account for the regulations, planning can proceed on facilities that take many years to design and construct, and costly future modifications to facilities can be reduced. Ways to account for future changes is to keep abreast of regulatory trends and to work with Ecology and other regulatory agencies as they develop new regulations. This collaborative strategy is in keeping with RWSP policy that directs WTD to work with state and federal agencies to develop cost-effective regulations and permit methodologies that protect water quality.

Even with this ongoing vigilance, unexpected changes in regulations and methodologies to implement the regulations can occur that may affect program planning and implementation. For example, between the planning phase and the NPDES permitting of the new Mercer/Elliott West and Henderson/Norfolk CSO storage and treatment facilities, Ecology changed the methods to identify the need for and define effluent permit limits. WTD will monitor these facilities for their compliance with these permit limits and will include the new methods in planning for future projects. In addition, promising treatment technologies will be evaluated for their ability to meet possible future requirements in pilot projects proposed for 2006–2009. (See the section on “Analyzing Rate Impacts” for a discussion of the evaluation of treatment technologies.)

The following sections describe WTD's efforts to comply with the Endangered Species Act and the effects on CSO control planning of new water quality regulations and permit compliance methodologies promulgated by Ecology since adoption of the RSWP.

4.3.1 Compliance with Endangered Species Act

The previous section in this chapter on “Identifying the Public and Environmental Health Benefits of Continuing the CSO Control Program” describes WTD's efforts to ensure that its activities, including CSO control, comply with the Endangered Species Act (ESA).

WTD considers the protection of endangered and threatened aquatic species to be an important part of CSO control planning decisions. Its habitat conservation planning process, begun to ensure that operations comply with ESA, produced important studies that have advanced the degree of knowledge regarding chemicals accumulating in the Puget Sound food web. At the same time, these studies brought to light uncertainties regarding the effects of these chemicals on aquatic species and the role of effluent in contributing to the pollution. Uncertainties also exist in regard to whether CSO control projects will require ESA consultations, because only projects with a federal link require such consultations.

4.3.2 Use-Based Water Quality Standards

In June 2003, Ecology made changes to state water quality standards. The new “use-based” standards are based on improving the quality of a water body to support uses by humans and aquatic species that are more specifically defined than in the previous standards. These changes may affect the design and operation of CSO treatment facilities that will discharge to the Duwamish River.

Most of the water bodies where County CSOs occur are included on Ecology’s 303(d) list for exceedance of standards for some water quality parameters. The possible impacts on CSO control planning of Total Maximum Daily Load (TMDL) allocations is uncertain because TMDLs have not yet been developed for these waters.¹⁰ To take a proactive stance in the process, the County partnered with Ecology to develop a model sediment TMDL. The purpose of collaboration was to ensure that TMDLs are technically sound and do not duplicate or conflict with other regulations. The model sediment TMDL, completed in 2001, was applied to Bellingham Bay, one of the first sediment TMDLs in the nation approved by EPA.

4.3.3 Water Quality–Based NPDES Permitting

A critical development since the RWSP is the inclusion of water–quality based limits to the permitting of CSO treatment facilities and changes in the methodologies underlying that permitting.

In the 1990s, the County had converted two former primary treatment plants—Alki and Carkeek—to CSO treatment plants. These plants were designed to meet the technology-based standards for solids control. At the time the plants were converted, effluent chemical concentration limits to protect aquatic species in the waters receiving the discharges—called water quality–based limits—were not expected to be applied to the infrequent, intermittent discharges from these plants.

In Washington State, technology-based standards require CSO treatment to be “equivalent to primary,” defined as achieving an annual average of 50 percent total suspended solids (TSS) removal and an annual average effluent quality of no more than 0.3 mL/L/hr of settleable solids (SS), with disinfection if needed. When the captured solids are piped to West Point, the percent of TSS removal for CSOs must be adjusted down to account for the losses that will occur in the subsequent treatment process. While Alki and Carkeek have always provided disinfection to any flows discharged to Puget Sound, the new NPDES permit that became effective January 1, 2004, (a part of the West Point permit) includes the requirement to disinfect discharges to meet water quality–based limits starting January 1, 2006. Dechlorination is now required to meet these limits.

¹⁰ Once it is included on the 303(d) list, the water body must be studied and controls must be put into place that will correct conditions so that it meets standards. Controls often involve dividing the pollutant load into allocations to its sources, such as stormwater runoff and municipal or industrial discharges, that the water body can assimilate and still meet the standards. This process is called a Total Maximum Daily Load (TMDL).

Technology-based standards were the compliance objective in 1997 when the facilities plan for the Mercer/Elliott West storage and treatment project was approved. The facilities were the first new CSO treatment facilities to be designed in Washington State. At the time, Ecology and EPA methodologies to assess CSO treatment project alternatives for their expected performance in meeting water quality standards were very limited and no water quality–based permit limits were expected. After considerable discussion with Ecology, County staff proposed methods to predict treated CSO effluent dilution that paralleled those used for secondary plants and developed alternatives whose effluent would meet water quality standards with that dilution.

Between approval of the Mercer/Elliott West facilities plan and NPDES permitting of the new CSO treatment facilities in 2005, methodologies to define CSO effluent dilution have become more concrete (using more stringent stormwater methodologies). These methodologies are now expected to be applied to treated CSO discharges, as evidenced by the Alki and Carkeek permit limits. These permitting goals are stricter than anticipated and may prove difficult for the new CSO treatment facilities to meet. Preliminary assessments indicate that treatment of CSOs containing dissolved copper, and possibly ammonia and dissolved zinc, may require enhanced management such as increased dilution, improved treatment technologies, and enhanced source control. Ecology has postponed decisions on water quality–based permit limits for these facilities until they can be made using actual treated effluent data. King County will also initiate discussions with Ecology to clarify how water quality–based standards will be applied.

Continued change is likely. Some environmental groups are requesting that Ecology require that standards for persistent and bioaccumulative chemicals be met at the end of pipes rather than at the edge of mixing zones. And developments for the Lower Duwamish Waterway Superfund effort may lead to more stringent sediment-driven standards and water quality–based and technology-based permit limits. King County will monitor new developments.

4.4 Analyzing Rate Impacts

The RWSP CSO control program recommended that 21 projects be built between 2005 and 2030. The total project constant capital cost for these projects was estimated to be \$311 million in 1998. In 2005 dollars, the projects are estimated to cost \$383 million.¹¹ The project schedule for the RWSP CSO control program was designed to spread costs over time and to support a stable sewer rate. The current RWSP program without any recommended refinements and updated estimating will contribute \$0.27 per month to rates in 2010, \$2.45 in 2020, and \$4.65 in 2030.¹²

¹¹ In addition to accounting for 3 percent per year inflation, this total reflects the deletion of the SW Alaska Street CSO project and the addition of CSO plan updates and sediment management activities that were mandated but not funded in the RWSP. (Monitoring and analysis indicate that the CSO at SW Alaska Street is controlled.) See Appendix C for a table that summarizes current RWSP project costs.

¹² These rates include 3 percent inflation per year, starting from 2005 dollars. The rates without inflation would be \$0.23, \$1.63, and \$2.22 for the same years.

4.4.1 Cost Estimating for CSO Control Projects

Cost estimating involves a narrowing process so as to limit resources and time spent on alternatives that will eventually be discarded for technical or cost reasons. The accuracy of cost estimates increases as projects become more defined and are specified in greater detail. Planning-level cost estimates, such as those used in the RWSP, are based on generic facility concepts. Specific details of the project such as location, technologies, and environmental impacts are determined later during project predesign. Planning level cost estimates are expected to be within +/- 30–50 percent of the final cost, with the wider range assigned when there is greater uncertainty about the project or greater risk to construct. By the time a project enters construction, estimates are typically within +/- 10 percent of the final cost.

Cost estimating methodologies change and improve over time. Since the RWSP, WTD has made several changes—including the use of improved construction and allied cost estimating models—to ensure that cost estimating is more standardized and consistent across projects.

No detailed analysis of CSO project costs has been done since the RWSP because an update of the hydraulic model—recommended by this review and currently under way—will likely change sizes, definitions, and thus costs of several planned control projects. However, similar to increased estimates seen for the original RWSP “North Plant” (Brightwater) and conveyance program, increased estimates for CSO control projects can be expected. Cost estimates may increase as the result of a number of factors, including greater definition of facility design, changes to accommodate new regulations and odor control policies, and increases in materials and contractor costs in this competitive construction environment.¹³ WTD has begun two activities that have the potential to offset cost increases that appear could result from changes in market conditions and estimating methods:

- The hydraulic model is being updated and calibrated so that it can more accurately update and refine project sizing.
- Pilot tests will be conducted on promising new CSO treatment technologies that may reduce facility footprint and cost.

These activities are expected to produce new project definitions and improved cost estimates for a next CSO control plan review in 2010. Rate impacts will be minimized to the extent possible in any new proposed control project schedules. WTD will continue to pursue grants and low-interest loans, such as the state loans recently awarded to three of the next four CSO control projects.

4.4.2 Evaluation of CSO Treatment Technologies

The RWSP calls for satellite CSO treatment for four CSO sites—King/Kingdome, Hanford/Lander, Brandon, and Michigan. Flows at these CSO sites are so high that storage

¹³ New odor control policies were adopted by the King County Council in 2003. The goal of the policies is to prevent and control nuisance odor occurrences at all treatment plants and conveyance facilities to standards that go beyond traditional odor control. Standards apply to both existing and new facilities.

facilities to hold all the flows would be large, difficult to site, and prohibitively expensive. Even if such storage facilities could be built, they could not be drained to regional plants before the next storm begins to fill them again.

As part of its ongoing planning, the County searches for new technologies that can increase effectiveness, meet new and more stringent permit requirements, and/or reduce costs. For this 2005 CSO program review, studies on the newer solids removal and disinfection technologies were reviewed for quantifiable performance data that could be directly compared with performance and associated costs of the more conventional technologies.

At the time of the RWSP, conventional primary sedimentation (or vortex separators) for solids treatment and hypochlorite for disinfection were considered the best available technologies for these sites. The 2000 CSO control plan update reviewed emerging technologies for their potential application to the CSO control program. It was recommended that new technologies were not sufficiently developed to replace those included in the RWSP, that the experience of other agencies in testing and implementing some of the more promising technologies be monitored, and that pilot studies be conducted in the future.

On March 1, 2005, a technology workshop was conducted to examine the results of the most recent literature review and to discuss the suitability of the technology to meet County needs and objectives. Over 50 people attended, most representing WTD but also including representatives from Ecology and the City of Seattle. An expert panel reviewed literature results ahead of the workshop and spoke to the group on the current national experience in the use of sewer separation, optimized storage, floatables control, real-time flow control, vortex treatment, tunnel treatment/optimized storage, and high-rate disinfection.¹⁴ No expert with experience operating full-scale ballasted-type treatment technologies for systems similar to the County's could be found to participate in the panel, an indication of the newness of this technology.

A follow-up workshop for County staff was held June 16, 2005. Results and recommendations of the first workshop were reviewed. New information on key treatment process parameters and general costs were presented, with an emphasis on the ballasted processes. Implementation issues, including operations and maintenance issues and projected process effluent quality (metals and disinfection byproducts), were discussed.

Conclusions from both workshops are that little new information has come to light since 2000 that warrants a change from the RWSP approach of storage, conventional primary treatment, and chlorine (typically hypochlorite) disinfection. As before, it was recommended that WTD continue to monitor the ballasted sedimentation and UV disinfection processes for performance data from other entities. In addition, because of the potential cost savings of smaller footprint facilities, it was recommended that pilot tests be conducted now and detailed cost estimates be developed for variations of the ballasted sedimentation process that hold the most promise. Pilot testing will begin in 2006. Appendix C provides more detail on the review process, the technologies that were considered, and the results of the review.

¹⁴ The panel consisted of the following people: Gerry Shrope and Vernon Thompson, CTE-AECOM; Ted Burgess, CDM; Steve Merrill, Brown & Caldwell; and David Bingham, Metcalf & Eddy.

4.5 Ensuring the Program Will Honor and Be Consistent With Long-Standing Commitments

The RWSP CSO control plan represents a responsible approach to controlling CSOs on behalf of the 34 local agencies that contract with King County for wastewater conveyance and treatment. The plan takes into account commitments made to these agencies and to communities and regulatory agencies through agreements and other mechanisms. In keeping with RWSP policy commitments, the plan will be modified, when needed, to respond to emerging developments in science and technology and to changes in regulatory requirements.

The County is upholding the agreements made by the King County Executive and the Regional Water Quality Committee (RWQC) in 1998 at the Robinswood conference center. The “Robinswood” agreements laid out guiding principles for funding the RWSP. It was agreed that the wastewater system is a regional system and that King County will do the following:

- Maintain a uniform monthly sewer rate for both existing and new customers such that, in general, existing customers pay for the existing system and new customers pay for growth.
- Establish a uniform capacity charge for new customers within the service area to cover growth-related costs not captured by the monthly sewer rate.
- Develop a proposed legislative strategy for increasing the capacity charge by including in its calculation the growth-related costs in the RWSP. Build a coalition for supporting the strategy in the Legislature.
- Maintain the current rate structure until the capacity charge is changed.
- Require King County to pay 100 percent of the cost of inflow and infiltration (I/I) assessments and any pilot projects that are done to demonstrate I/I effectiveness.
- Discontinue the combined sewer overflow benefit charge (Seattle CSO payment) when changes in state legislation authorizing a higher capacity charge are passed.

In the 2000 state legislative session, King County successfully pursued changes in state law to attain greater flexibility in setting the capacity charge. Per the agreement, the County then discontinued the Seattle CSO payment.

WTD strives to meet its commitment to use ratepayer dollars wisely in a number of ways. It coordinates the CSO program with other WTD programs and agreements for maximum benefit at least cost. New technologies are monitored to ensure that the most cost-effective technologies are used. CSO and RWSP annual reports review County wastewater management and water quality programs to eliminate redundancies or conflicts in programs. The CSO control program coordinates with the City of Seattle CSO control program to identify mutual project opportunities, minimize community impacts, and ensure equitable and cost-effective programs.

WTD continues its commitment made to the public and Ecology to make steady progress toward control of all of its CSOs by 2030. Scheduling flexibility is maintained within that timeframe to take advantage of concurrent or joint project opportunities or to respond to changing needs.

The CSO control plan honors the West Point Settlement Agreement.¹⁵ This agreement limits the footprint of the plant to the size that would enable one more expansion to 159 mgd without increasing the discharge of pollutants above that permitted by the 1996 NPDES permit. The existing plant routinely processes CSO flows, and any updates and expansions to the plant will account for CSO control.

The CSO control program supports the 1990 settlement agreement with NOAA to repair natural resource damages in Elliott Bay and the Duwamish River from City of Seattle and King County CSOs and Seattle storm drains. To fulfill the agreement, the City and County funded and participated in an effort to clean up historically contaminated sediments and conduct habitat restoration projects in these water bodies. The fund and projects were administered by the Elliott Bay/Duwamish Restoration Panel (EBDRP), made up of natural resource trustees.¹⁶ Projects included the Norfolk remediation, the Diagonal/Duwamish remediation, waterfront assessments, and a few habitat projects. Work under this agreement was completed in 2004, at the close of the Diagonal/Duwamish remediation.

4.6 Assessing Public Opinion

WTD's ongoing public involvement program informs and engages the public and local agencies in planning, design, and operating decisions that affect them. Public involvement activities helped to shape the RWSP, including its CSO control element. The program has become more defined since adoption of the RWSP, while still remaining within the 1999 policy framework.

This section presents the CSO-related conclusions of a stakeholder committee for the water quality assessment that was completed shortly before adoption of the RWSP. It also describes RWSP public involvement processes.

4.6.1 Stakeholder Committee for the CSO Water Quality Assessment

In addition to the RWSP public process, a stakeholder committee provided valuable input to the CSO control program through the *Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay* (WQA). The members of the committee are listed in Appendix C. Appointed in November 1996 and serving through the publication of the reports in 1999, its work included participation in full-day workshops and half-day working sessions to

¹⁵ The West Point Settlement Agreement is an agreement made with community, civic, and environmental groups that allowed the upgrade of the West Point plant to secondary treatment to go forward.

¹⁶ EDBRP trustees are NOAA, the U.S. Department of the Interior, the U.S. Fish and Wildlife Service, the Bureau of Indian Affairs, the Washington State Department of Ecology, the Suquamish Tribe, and the Muckleshoot Indian Tribe.

review specific details of the project, followed by preparation of a report covering key points of consensus.

The committee's conclusions regarding CSO control include the following:

- In some areas, existing sediment quality and associated risks to people, wildlife, and aquatic life in the Duwamish River and Elliott Bay are unacceptable.
- Current levels of human pathogens and fecal coliforms in the Duwamish River and Elliott Bay are unacceptable because of the risk to public health.
- Controlling CSOs according to the Executive's Preferred Plan (RWSP) will improve some aspects of environmental quality.
- Even if CSOs are completely eliminated, overall environmental quality will continue to be unacceptable.
- CSOs need to be controlled as part of the comprehensive regional program.

4.6.2 RWSP Public Involvement Activities

Since the RWSP was adopted, public opinion has been collected through a variety of venues; most are not specific to CSO control but still provide insight into the values and preferences of the public. For example, public involvement programs for I/I control, the Habitat Conservation Plan, water conservation education, water reuse, and various WTD construction projects have provided many opportunities to engage the public and hear opinions on water quality and wastewater management issues having relevance for CSO control.

To ensure a consistent approach, public involvement guidelines for WTD projects were developed to help staff develop and implement public involvement programs and coordinate public outreach activities for multiple WTD projects in the same geographic area. In addition, a comprehensive centralized database was developed that tracks public contacts and outreach activities to increase coordination and efficiency of outreach efforts.

The messages heard during RWSP formation—that water quality is a priority to the citizens of King County, that the County has a mandate to protect and enhance water quality, and that the citizens believe CSOs should be controlled—has been continually reaffirmed through all WTD public involvement activities since the RWSP was adopted. In its recent annual water quality survey, King County repeated questions asked in 1997 and heard similar results: 79 percent of respondents said that the County should prevent CSOs into Puget Sound, rivers, and lakes during storms, even if it costs more per month in our sewer rates; only 4 percent believed controlling CSOs was not worth such investments.

In preparation for the 2008 CSO control plan update to Ecology, King County will conduct a public involvement program to identify current attitudes about CSO control, control priorities, and possible schedule changes. WTD staff will also be meeting with federal, state, and tribal agencies to discuss the 2008 plan update and any proposed changes. Also, 1 year prior to the 2008 submittal of permit renewal materials, King County and Ecology will conduct a meeting with stakeholders and interested parties to hear their issues or concerns about the West Point

permit renewal. This meeting will offer another opportunity to learn of any CSO-related issues. The messages heard to date, information resulting from this program review, and any new public opinion heard during the plan updating process will shape the program to be in keeping with the expectations of our citizens.

A focused information and involvement effort in support of predesign for the next CSO control projects—Barton, Murray, Magnolia, and North Beach—will begin later in 2006 to gather community input and to provide information on the projects. The results of these meetings will give decision-makers information to consider along with technical and rate impact studies in deciding on any changes to the CSO control program.

As is done with all WTD projects, community relations plans will be prepared for construction of each CSO control project. The public will be kept informed of the project and community impacts via fliers, signs, direct contact, and 24-hour project hotlines. Staff will be available to respond immediately to questions and concerns. And control projects will include features, such as noise mitigation and odor control, to minimize long-term impacts on neighbors.

Ongoing public involvement activities indirectly related to CSO control projects include the following:

- Providing information about CSO projects to communities in conjunction with other WTD projects occurring in the area.
- Discussions with the Duwamish River Cleanup Coalition, a public outreach group convened by EPA and funded by the Lower Duwamish Waterway Group (including King County) to provide input on sediment cleanup projects and public outreach.
- Conducting a variety of public information and outreach activities including speaker's bureau, community open houses, wastewater treatment facility tours (treatment plants, CSO facilities, pump stations), and booths at community fairs and festivals.

4.7 Integrating the CSO Control Program with Other Water and Sediment Quality Improvement Programs for the Region

To save costs, improve efficiencies, and reduce redundancies, the CSO control program integrates its work with both internal and external programs aimed at improving water and sediment quality in the region.

Just as the 1998 CSO water quality assessment (WQA) provided information that could be applied to other WTD programs, these other programs generate information that is invaluable to CSO control planning. The studies done on bioaccumulative and endocrine disrupting chemicals in support of the Habitat Conservation Plan, for example, supplemented data in the 1998 water quality assessment and provided direction for future studies to better understand the role of such chemicals in planning for CSO treatment projects. WTD also coordinates with other divisions in

the Department of Natural Resources and Parks, such as the Water and Land Resources Division whose scientists routinely participate in and provide water and sediment quality information in regard to CSO control.

King County and other entities in the region conduct water quality monitoring and participate in water quality protection programs, such as the studies being done in support of salmon conservation in the two major watersheds in King County. The WTD CSO control program makes an effort to keep informed of this work, identifies new science that is relevant to CSO control planning, coordinates efforts for complementary results, and negotiates joint work where interests overlap.

The CSO control program makes every effort to coordinate CSO control projects with wastewater system upgrade and refurbishment projects to optimize designs, share mutual project costs, and minimize community disruption. For example, upgrades to the Barton Pump Station were expanded to the maximum capacity that the station can accept in order to minimize the size of the anticipated CSO control project. Likewise, emergency repairs of the Barton force main and Ballard siphon have considered CSO control plans to the extent possible without delaying the repairs. The siphon repair may control CSOs at the Ballard location without the need for a later control project.

WTD and the City of Seattle are consulting on ways to coordinate CSO control projects in overlapping areas and to handle the addition of more City CSO flows into the County conveyance and treatment system. The RWSP defined the Ballard CSO control project as a joint project with the City. Now that the Ballard project may not be needed as the result of siphon replacement, WTD has offered the City the opportunity to contribute incremental costs to provide capacity in the siphon for the City's Ballard CSOs. If the City wishes to explore this opportunity further, the implications for siphon sizing, buildability, and West Point capacity will be assessed. Other projects that will be evaluated include the City's Windermere and the County's University Regulator projects, as well as a possible joint storage project in the Madison Valley and Montlake areas. These opportunities for coordination will be considered in the 2008 CSO plan update.

The County has worked with the City and other agencies on sediment remediation and source control projects. Since 2000, King County, Port of Seattle, City of Seattle, and Boeing have been involved in efforts under the federal Superfund program to better understand the human and environmental risks from contaminated sediments in the Lower Duwamish Waterway and to take actions where necessary. As the result of early proactive discussions with Ecology and EPA before the area was listed under Superfund, the County, City, and Port have been allowed unprecedented access and participation in the initial remedial investigation and feasibility study (RI/FS). Two of the early action sites recommended in Phase 1 of the RI were near King County CSOs: Norfolk and Diagonal/Duwamish. Sediment near the Norfolk site had already been remediated in 1999 by King County, working with the City of Seattle and the EBD RP. Similarly, King County was the lead agency, with participation by the City of Seattle and funding from the EBD RP, for remediation of the Diagonal/Duwamish site, completed in 2004.

Chapter 5

Next Steps

This CSO program review reaffirms the priorities of protecting public health, the environment, and endangered species that shaped the development of the RWSP CSO control program. It also has added weight to WTD's practice of transferring as many CSO flows as possible to regional treatment plants for best available treatment.

In mid 2006, predesign will begin on the first four CSO control projects on the list—South Magnolia, Murray Avenue, Barton Street, and North Beach.¹ These projects are storage or conveyance projects that will transfer flows to regional treatment plants. The County has been awarded State Revolving Fund loans to develop facility plans for the Murray Avenue, Barton Street, and North Beach projects. At the recommendation of the Washington State Department of Ecology (Ecology), WTD will reapply for loans for the South Magnolia project.

Improvements to the program and facilities, identified as a part of this review, have been implemented or are in progress. The hydraulic model used to predict the effectiveness of CSO control and to design CSO control projects is being updated and recalibrated as the result of discrepancies between modeled and monitoring data found during this review. The updated model, expected to be ready in 2007, will provide more accurate information on remaining control needs.

This review revealed upward cost pressures on the CSO control program. Changes in regulatory guidance may have raised regulatory targets for the CSO control program approach, requiring further exploration of new technologies and subsequent changes to design of CSO control facilities. New technologies, such as variations on high-rate sedimentation treatment processes, that offer some promise for greater cost-effectiveness will be piloted between 2006 and 2009.

When the hydraulic model is updated, projects may be resized, any necessary technology changes will be incorporated, and new cost estimates will then be developed. Some of this information, including any recommended schedule changes to address new scientific information, may not be available for the 2008 plan update; all the information should be available for discussion ahead of the next CSO control program review in 2010—and well ahead of commitments to Ecology for the CSO plan update that follows the review.

¹ The SW Alaska Street project is no longer needed; updated monitoring and modeling data indicate that this CSO is already controlled.

Appendices

Appendix A. RWSP CSO Planning Assumptions, Policies, and Implementation

Appendix B. Description of Models Used for Metro/King County CSO Planning

Appendix C. CSO Control Program Review Detail

Appendix A

RWSP CSO Planning Assumptions, Policies, and Implementation

RWSP CSO Planning Assumptions

Following is the list of assumptions used for CSO planning in the Regional Wastewater Services Plan (RWSP). These assumptions are still valid except where noted as being updated in the 2004 RWSP Update.

- During 1997 RWSP public involvement process, citizens ranked CSO control as a top priority
- King County shall design, construct, operate, and maintain its facilities in accordance with standards established by regulatory agencies and manuals of practice for engineering, so as to meet or exceed regulatory requirements for air, water, and solids emissions, as well as ensure worker, public, and system safety.
- King County will meet the state CSO control standard of one untreated overflow per year on average, recognizing that this may become more stringent in the future due to ESA.
- The City of Seattle has controlled all its CSOs, and no further deterioration in its system is expected.
2004 Update: The City was required to monitor all of its CSO locations and found that some of its CSOs are not controlled. The City was required to develop an amendment to its 1988 plan to bring all sites into control. The control approach chosen by the City is to optimize conveyance and store flows for later transfer to the County for treatment at West Point.
- The RWSP CSO control program includes storage tanks and on-site treatment. Investigation is needed to determine if a roof drain disconnection program conducted by homeowners would be cost-effective before it is used for control.
- King County shall give the highest priority for control to CSO discharges that have the highest potential to impact human health, bathing beaches, and/or species listed under ESA.
- The County will develop CSO programs and projects based on assessments of water quality and contaminated sediments.
- Although King County's wastewater collection system is impacted by the intrusion of clean stormwater, conveyance and treatment facilities shall not be designed for the interception, collection, and treatment of clean stormwater.
- The County will develop a contaminated sediment management plan.
2004 Update: The plan was completed in 1999 and is being implemented.

RWSP CSO Policies and Implementation

The following are RWSP policies for the CSO control program and the status of their implementation as of the 2004 RWSP Update. Implementation status as of 2006, compiled as a part of the CSO control program review, is noted.

Combined Sewer Overflow Policies	How is Policy Being Implemented?
CSOCP-1: King County shall plan to control CSO discharges and to work with state and federal agencies to develop cost-effective regulations that protect water quality. King County shall meet the requirements of state and federal regulations and agreements.	<p>The County has participated in the Washington State Department of Ecology process to define the CSO "event."</p> <p>King County is participating in Ecology's deliberations on new water quality standards and 303(d) listing policies.</p> <p>The Sediment Management Program is investigating if proposed levels of CSO control will be sufficient to meet sediment standards and is working to obtain sediment impact zones for current discharges that cannot meet standards until control projects are completed.</p>
CSOCP-2: King County shall give the highest priority for control to CSO discharges that have the highest potential to impact human health, bathing beaches and/or species listed under ESA.	<p>The Denny Way/Lake Union control project, located at a heavily used public park, and the Henderson/Martin Luther King/Norfolk control project, located on Lake Washington near a public beach, are currently in construction and will be complete in 2005.</p> <p>2006 Status: <i>Projects were completed May 2005.</i></p> <p>The current RWSP project schedule aligns with these priorities.</p> <p>Risk assessments are being conducted as part of some early sediment cleanup actions to determine if there is potential for localized risk from individual CSOs or if there are sediment impacts to ESA-listed species.</p>

Combined Sewer Overflow Policies	How is Policy Being Implemented?
CSOCP-3: Where King County is responsible for stormwater as a result of a CSO control project, the county shall participate with the City of Seattle in the municipal stormwater national pollutant discharge elimination system permit application process.	<p>King County WTD has been participating in the discussions on renewal of the NPDES municipal stormwater permit. Ecology has clarified that the Lander storm drain does not require King County to be a co-permittee with the City of Seattle, but the Densmore drain project does.</p> <p>The City drainage ordinance exempting the City from responsibility for source control in combined areas raised awareness that there is a gap in stormwater pollution prevention services in the combined areas. The City and County are currently in discussion to address this need.</p> <p>2006 Status: <i>The City's new NPDES permit (12/1/05) now requires that their Nine Minimum Controls pollution prevention programs be implemented in the combined areas. Coordination discussions between the County and City will be needed.</i></p>
CSOCP-4: Although King County's wastewater collection system is impacted by the intrusion of clean stormwater, conveyance and treatment facilities shall not be designed for the interception, collection and treatment of clean stormwater.	<p>Discussions are underway with the City of Seattle and the Washington State Department of Transportation regarding possible discharge of stormwater and dewatering water to the King County system. The County is reviewing the industrial waste dewatering water policies.</p>
CSOCP-5: King County shall accept stormwater runoff from industrial sources and shall establish a fee to capture the cost of transporting and treating this stormwater. Specific authorization for such discharge is required.	<p>The Industrial Waste Program recovers costs for such discharges.</p>
CSOCP-6: King County, in conjunction with the city of Seattle, shall implement stormwater management programs in a cooperative manner that results in a coordinated joint effort and avoids duplicative or conflicting programs.	<p>Management programs are being jointly conducted in basins discharging to sediment cleanup sites to identify potential sources of recontamination and control those sources. King County is negotiating with the City of Seattle regarding which agency should be responsible for stormwater pollution prevention activities in the combined sewer areas of the City.</p> <p>2006 Status: <i>The County has contributed significantly to the planning for stormwater management related to the Alaskan Way Viaduct replacement project. See CSOCP-4. The City's new NPDES permit requires the City to perform the Nine Minimum Controls stormwater pollution prevention activities in the combined sewer areas of the City. See CSOCP-3.</i></p>
CSOCP-7: King County shall develop a long-range sediment management strategy to prioritize clean up of contaminated sediments at specific CSO locations.	<p>Completed in 1999 and in implementation.</p>

Combined Sewer Overflow Policies	How is Policy Being Implemented?
<p>CSOCP-8: King County shall use the results of the 1998 water quality assessment to assess CSO control projects and priorities before issuing the year 2000 CSO update required by the county's national pollutant discharge elimination system permit. Prior to the year 2005 CSO update, the executive shall evaluate the benefits of CSO control projects along with other pollution control projects developed by King County and other agencies. This CSO program review will include, but not be limited to the following: maximizing use of existing CSO control facilities; identifying the public and environmental health benefits of continuing the CSO control program; ensuring projects are in compliance with new regulatory requirements and objectives such as the ESA and the Wastewater Habitat Conservation Plan; analyzing rate impacts; ensuring that the program review will honor and be consistent with long-standing existing commitments; assessing public opinion; and integrating the CSO control program with other water/sediment quality improvement programs for the region. Based on its consideration of the CSO program review, the RWQC may make recommendations for modifying or amending the CSO program to the council.</p>	<p>Water Quality Assessment (WQA) results are used in development of cleanup actions and in decisions about when the Sediment Management Program will need to be involved in other initiatives. The CSO program review and 2005 update process are just beginning and will be reported on in the 2007 RWSP 3-year update report. Regional focus groups are planned to assess public opinion for the 2005 CSO plan update.</p> <p>2006 Status: <i>In the 2004 renewed NPDES permit, Ecology changed the due date for the next CSO plan update to 2008. This CSO program review addresses all of the required information. (See Chapter 4 of the program review report.) Public involvement is rescheduled to 2007: Predesign will begin in mid 2006 for the next projects (Barton, Murray, North Beach, and South Magnolia).</i></p>
<p>CSOCP-9: Unless specifically approved by the council, no new projects shall be undertaken by the county until the CSO program review has been presented to the council for its consideration. CSO project approval prior to completion of CSO program review (beyond those authorized in this subsection) may be granted based on, but not limited to, the following: availability of grant funding; opportunities for increased cost-effectiveness through joint projects with other agencies; ensuring compliance with new regulatory requirements; or responding to emergency public health situations. The council shall request advice from the RWQC when considering new CSO projects. King County shall continue implementation of CSO control projects underway as of the effective date of this section, which are the Denny Way/Lake Union, Henderson/Martin Luther King/Norfolk, Harbor, and Alki CSO treatment plants.</p>	<p>No projects beyond those listed are under way at this time. The CSO plan update will consider accelerating the Ballard project at the request of the City of Seattle, parts of the King and Connecticut projects as needed to coordinate with the WSDOT Viaduct & Seawall replacement project, and other projects associated with Superfund sediment remediation projects.</p> <p>2006 Status: <i>Ballard CSO control will likely be met through the project to replace the failing siphon. The City is considering whether to contribute incremental costs to the siphon project to size it to control its CSOs in the area. WSDOT is developing cost estimates to include pipelines for the future Kingdome/Connecticut project in its replacement of the viaduct. WSDOT structures may obstruct planned pipelines and result in increased costs if pipelines are not included in WSDOT construction. The County will weigh the costs to accelerate installation of these pipelines after the estimates are provided.</i></p>

Appendix B

Description of Models Used for Metro/King County CSO Planning

1979 CSO Control Program.....	B-1
1986–1988 CSO Control Plan	B-2
CATAD Program Improvements—Predictive Control Program Begins.....	B-3
The 1995 and 2000 CSO Control Plan Updates	B-4
SCADA/CATAD as of CSO Control Program Review	B-4

King County’s approach to modeling has changed over time. This has resulted from improvements in the science of modeling and available models, as well as improved information about the conveyance system. The history of this effort follows. It is also summarized in Table 1.

1979 CSO Control Program

In this program, models specifically developed for the 1976 Metro 201 Facilities plan were used. These included a model known as HYDRO to generate runoff from storms.

HYDRO used a synthetic unit hydrograph technique to calculate surface runoff from rainfall. The synthetic unit hydrograph is a triangular hydrograph of the flow that would result from one inch of rain in a ten-minute period. Unit hydrograph shape was dependent on the shape of the area from which runoff was being calculated. Two sets of independent calculations were performed for impervious and pervious surfaces.

Sanitary sewage flows were represented in the 1979 modeling by diurnal hydrographs adjusted in magnitude based on the land use of individual tributary areas. A base infiltration factor (usually 1,100 gpad, but adjusted for measured flows) was added to compute base sewage flow. Runoff computed by the unit hydrograph technique was then added to base wastewater flows.

The total flow hydrographs computed in each basin of the system were routed through Metro's interceptors using a model known as “NETWORK.” NETWORK was a specially developed model using a kinematic wave approximation to the full equations of motion. The kinematic wave approximation does not fully account for backwater effects from pump stations and regulator gates, or any other downstream flow restriction. Thus, a complete description the system operation was not available (the actual impact of throttling back on the Interbay pump station could not be precisely simulated for example). Because flows from the north end of the system were not large, these were simulated as a constant value in development of the 1979 plan.

1986–1988 CSO Control Plan

In the modeling effort for the 1986–1988 CSO Control Plan, consultants used different programs to generate inflow hydrographs from the separated and combined portions of the service area. For the separated sewer area (upstream of the Lake City Regulator) the program LCHYD was used to generate flows from nine sub-basins. A diurnal base flow (e.g., showing two peaks within the same day) hydrograph was developed based on domestic/commercial and industrial populations. A linear relationship was assumed between rainfall and inflow, up to a maximum amount. Infiltration was assumed to be constant for the wet season. A maximum inflow value of 500 gallons per acre per day (gpad) was used for simulating future flows from currently non-sewered areas that were expected to develop and include sewers in the future.

The program LCPRE was used to take into account that peak flows do not occur at the same time in all parts of the system. This lag was incorporated into the simulation.

For the combined system, the program HYDRO72 was used to generate hydrographs from 19 basins in the Northern service Area (NSA). This was a modification of the HYDRO program used in the 1979 CSO control program. Several of the basins in the HYDRO simulation were combined for use in the HYDRO72 model. Furthermore, the length of simulation was increased from 24 hours to 72 hours for HYDRO72, which allowed for longer storm events to be simulated.

The same basin parameters from the 1979 CSO Control Program effort were used in the 1986 effort. Despite concerns about the model, a decision was made to continue using the model for continuity with past planning. Five design storms were used to estimate annual CSO volumes and frequencies under existing (at that time) conditions and under future conditions.

The input hydrographs were then used as input to the SACRO (Seattle Area Central Routing Organization) simulation. SACRO simulated the routing of flow through the northern service area (NSA) of the wastewater system. It was designed to give reasonable estimates of the volume of flow through the NSA system. The flow from Interbay Pump Station was assumed to remain the same throughout the study period (1982–2030).

For the wet season, it was assumed that infiltration would remain the same as in the 1981–83 model calibration, at 1100 gpad. HYD72 (similar to HYDROT2) was used to generate synthetic unit hydrographs from 62 basins in the SSA. Seven design storms of varying length and intensities were used to estimate annual CSO frequencies and volumes for the SSA.

The Southern Service Area (SSA) large pipe flow was simulated using SSACRO (South Seattle Area Control Routing Organization). It was developed using primarily SACRO and some of NETWORK. It is based on level pool storage routing concepts and therefore does not accurately represent dynamic wave storage or routing. The program only calculated how the different input hydrographs travel through the system – combining sewer junctions, splitting at diversions, etc. It did not simulate the restriction of flows at the Interbay Pump Station due to flows at the West Point treatment plant exceeding its setpoint, which at that time was 325 million gallons per day.

SSACRO and SACRO basically added up all flows into a particular node (regulator, pump station, etc.), subtracted away that which could be hydraulically conveyed away from the node,

and if anything was left, it was either stored or called an overflow. They are mass balance models, and do not compute water surface elevations in the collection system.

The program EBIPRE was developed to simplify and reduce the time involved in routing flows through the Elliott Bay Interceptor. It lagged inflow hydrographs and then combined them to be used in the routing model SSACRO. It also accounted for some of the City of Seattle CSOs and storage projects.

SACE (Seattle Area Combined Sewer Overflow Evaluator) was written to allow rapid testing of alternatives and to determine recurrence periods of overflows for design events. It calculated annual overflows for the wastewater system for the 1942-84 period. The SACE program simply assigned portions of each rainfall event to (1) system capacity; (2) system storage; and (3) rainfall that couldn't get into the sewer. The amount of available storage was increased during inter-event periods to reflect the draining of wastewater from storage. For each rainfall event, the wastewater entering the sewer that could not be contained in “system capacity” or “system storage” was considered to be CSO. There was no simulation of the flow as it proceeded toward the treatment plant.

CATAD Program Improvements—Predictive Control Program Begins

In 1986, a different approach was begun to model the West Point (combined) system, leaving behind the previous model. The effort was to support the development of an optimized real-time control program for the West Point collection system. The Predictive Control Program was to allow the Computer Augmented Treatment and Disposal System (CATAD) to automatically operate regulator gates and optimize in-line storage throughout the entire collection system to minimize CSOs.¹

As part of this new approach, two new programs were developed to simulate flow through the West Point system. A kinematic wave runoff program was developed to simulate overland flow resulting from rainfall. Flow over both pervious and impervious areas that enters the sewer system was simulated. The West Point system was divided into over 400 basins to simulate this overland flow. This flow was then routed through a kinematic wave transport program, which effectively simulates the lagging and attenuation of flows through the local sewer pipes. The program also computes depths and velocities of flows in each pipe, and is a good approximation of actual conditions as long as there are no backwater effects or hydraulic transients (e.g., hydraulic phenomenon that are short in duration). Unlike previous programs used to model the wastewater, the runoff/transport program is a physically-based model that attempts to directly simulate the flow mechanics of the local sewer system. The program simulates a diurnal base domestic flow and a constant groundwater leakage. Inflow from rainfall induced hydrographs were simulated and input into the appropriate pipes for routing.

¹ Automatic control by CATAD was implemented in 1974. Predictive Control optimizes it.

Over 70 flowmeters were installed to calibrate the runoff/transport model in the late 1980s.

The model UNSTDY was obtained in 1986 from Colorado State University to simulate the routing of runoff/transport flow hydrographs through the Metro/King County trunks and interceptor system. UNSTDY is a complex, fully dynamic simulation that computes flows, depths, and velocities in all pipes in the system. The full hydraulic equations are solved implicitly which enables it to simulate backwater effects, flow reversals, and gravity waves effectively. This sophistication was required to accurately simulate the in-line storage being utilized throughout the collection system. The model was enhanced to simulate the operation of the regulator gates and pump stations.

UNSTDY was programmed to simulate the regulator system using local control (manual control), the existing Automatic Control, and the new Predictive Control. In early 1992 it was discovered that several of the level sensors (bubblers) were reading incorrectly, and probably had been since installation. The UNSTDY simulation was modified to be able to simulate control structures as they would have been operated if the sensors were reading incorrectly, as well as if they were reading correctly. This option (which simulates flow assuming errors in the levels sensors) is used when simulating conditions under “baseline” (1981 -83) conditions.

The runoff/transport program was enhanced in the early 1990s to include rainfall-induced infiltration into the sewer system. This infiltration can be the largest component of I/I during large storms in the separated portion of the County sewer system. This modification allows King County to simulate the flow from the northern part of the West Point service area much more accurately than had been possible previously.

The 1995 and 2000 CSO Control Plan Updates

For the 1995 CSO Control Update the same seven design storms used in the 1988 plan were used to estimate annual CSO volumes. For the 2000 CSO Control Update, 11-year continuous simulations were used to estimate CSO frequencies and volumes. As each flow transfer or CSO project is constructed, UNSTDY is modified to include that facility. For example, the Hanford/Lander Separation Project is included for simulations past 1990. The Carkeek flow transfer was included beginning in 1994. The Allentown Diversion was included in 1996. The Alki Flow transfer was included in 1998 as was the University CSO Project (Densmore Pump Station). The Denny Way CSO facility, the Harbor CSO transfer to the West Seattle Tunnel, and Henderson/Martin Luther King Way CSO facility are being simulated for 2005 and beyond.

SCADA/CATAD as of CSO Control Program Review

Computer hardware at West Point has been replaced in 2004–2005 for the offsite facilities. Software upgrades have also been done for operating the offsite facilities and for collecting, storing, and retrieving their data. The links and software are currently undergoing QA/QC. New control strategies are being tested and implemented for the facilities that came online in 2005.

Table 1. Summary of Hydraulic Models Used by King County

Decade	Models		Brief Description of Capabilities
	Hydrologic (surface runoff and local system flows)	Hydraulic (Metro/KC trunks and interceptor flow)	
1970s	HYDRO		Used synthetic unit hydrograph method for runoff due to rainfall from 58 NSA basins and 62 SSA basins.
		NETWORK	Used kinematic wave approximation for simulating flow through Metro trunks and interceptors.
1980s	LCHYD		Used diurnal base flow and constant infiltration to generate hydrographs from separated areas. Linear rainfall/inflow relationship.
	HYDRO72		Used synthetic unit hydrograph method for 19 basins in NSA.
	HYD72		Used synthetic unit hydrograph method for 62 basins in SSA.
		LCPRE	Lagged the hydrographs from LCHYD to put into SACRO.
		SACRO	A mass balance model that simulated flow through the NSA. (Kept track of flow but didn't solve hydraulic equations for levels.)
		SSACRO	A mass balance model that simulated flow through the SSA.
		EBIPRE	Lagged the hydrographs from HYD72 to put into SSACRO.
		SACE	Estimated total system overflows based on rainfall only.
1990s — 2000s	RUNOFF		Kinematic wave simulation of runoff due to rainfall from > 400 basins. Variable inflow and infiltration based on rainfall and soil conditions. A physically based model.
		UNSTDY	<p>A fully dynamic simulation of flow through King County trunks and interceptors. Computes flows, depths, and velocities in all pipes in the system. Simulates backwater effects, flow reversals, gravity waves, surcharges, etc. Simulates automatic operation of regulator and outfall gates and pump stations. Also, simulates Predictive Control, a computer program that controls the regulator gates to optimize the use of in-line storage.</p> <p>Used seven design storms in early 90s to estimate annual overflows. Now continuous 11-year simulations are run to estimate annual averages.</p>

NSA = Northern Service Area (North of the Ship Canal)
SSA = Southern Service Area (South of the Ship Canal)

Appendix C

CSO Control Program Review Detail

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Maximizing Use of Existing CSO Control Facilities

The review assumed that cost-effective use of facilities resulted not just from good operation and maintenance of physical structures and optimized control strategies, but also efficient coordination and communication between the employees carrying out those activities. The review included physically inspecting each CSO facility and rain gauge to supplement ongoing inspection programs, reviewing monitoring data, and making improvements based on the inspections and review. The scope was then broadened to include topics such as control program organization, coordination, and communication as means to effective program implementation. A workshop and follow-up meetings were held across the division not only to identify ways to maximize the use of existing facilities but also to improve the coordination framework and methodologies that implement the program. An outcome of these meetings was a survey of staff to identify their communication needs and various approaches to meet these needs. Key survey recommendations are being implemented.

Inventory of CSO Control Roles and Responsibilities

The first step of this part of the review was to inventory roles and responsibilities within WTD that relate to these tasks. Almost every group in WTD is involved in the program to some extent, including wastewater treatment plant operators and planning, capital improvement, and asset management staff. Groups with diverse responsibilities and in diverse locations must coordinate their activities. An additional challenge to coordination is the division of the operation, maintenance, and offsite groups into two sections—West and East—that roughly correspond to where flows are sent, either to West Point or South plant.¹ The groups and their responsibilities as they relate to CSO control are presented in the following sections.

Operation, Maintenance, and Offsite Staff

West Section staff:

- Use SCADA to maximize the movement of flow to the West Point plant for secondary treatment and to use all available capacity in the system through in-line storage.
- Maintain dry-weather wet well level at the largest pump station when a storm is approaching. This enables the collection system to convey more flow to West Point before the storm or during the initial part of a storm and to free more storage or conveyance capacity for the storm flows.
- Operate the Carkeek and Mercer/Elliott West CSO treatment facilities.

¹ “Offsite” refers to facilities such as pump stations that are not part of a treatment plant site.

East Section staff:

- Manage combined sewer system flows from the southeast part of the Seattle area via the Allentown Diversion.
- Operate the Alki and Henderson/Norfolk CSO treatment facilities and the Alki conveyance system.

Both West and East Section staff:

- Operate and conduct normal maintenance programs to ensure reliable operation of pump and regulator stations.
- Plan for wet season operation of the CSO treatment plants and facilities.
- Coordinate seasonal flow-swaps at the York Pump Station, diverting flows to the South plant to relieve the west side combined sewer system in the winter.

Planning Staff

In general, planning staff are responsible for modeling, flow monitoring, program management, permitting, and industrial waste:

- **Modeling.** Estimates current and future conditions to assess control progress, supports upgrades to the CATAD/SCADA system, recommends system set points to optimize system operation, and provides targets for new facility design.
- **Flow Monitoring.** Directs the placement of portable monitors; downloads and assesses flow data used for compliance reporting, progress measurement, and facility design.
- **Program Management.** Coordinates plan implementation, annual reports, plan updates, and regulatory/policy review.
- **Permitting.** Coordinates NPDES permit compliance, provides liaison with the Washington State Department of Ecology (Ecology), and provides regulatory interpretation and planning.
- **Industrial Waste.** Permits discharges into the system, sets standards for pollution prevention and volume control, and conducts source control efforts in separated basins and upstream of sediment remediation sites.

Asset Management Staff

- **Inspection staff.** Place and manage portable monitors, inspect offsite facilities such as pipelines, siphons, and outfalls, and conduct normal maintenance programs to ensure the integrity and reliable operation of the offsite facilities.
- **Engineering Staff.** Provide interagency project coordination and implement any needed system refurbishment or upgrade projects.

Major Capital Improvement Program Staff

- Coordinate predesign through construction of major facilities.
- Manage contracts.

Workshop and Staff Survey

A workshop was held on November 16, 2004. The purpose of the workshop was to identify ways to improve the use of existing CSO facilities, including ways to improve coordination and communication among the employees supporting the program. In January and February 2005, two follow-up meetings were held with treatment plant and engineering staff to review the workshop findings.

Workshop participants proposed a vision statement for a well-coordinated CSO control program and goals to support the vision statement. The vision statement and goals will continue to be discussed and refined to ensure that they represent an agreed-on agency approach. Participants also discussed past experiences to help them identify coordination hurdles and ways to overcome them. Some of the resulting suggestions are as follows:

- **Communication**—Develop more formal communication channels for CSO information across the various WTD Workgroups.
- **Staffing**—Identify or confirm a central figure with authority to address staff needs and CSO work activities across the various WTD workgroups.
- **Data**—Provide up-to-date information systems with simpler data access or transfer capabilities.
- **Guidelines**—Develop CSO control optimization guidelines that better integrate CSO within the overall WTD.
- **Regulatory**—Continue to involve the regulatory agencies in initial planning, and educate WTD staff on regulatory requirements for CSO.
- **Incentive**—Encourage innovation and ideas for improvement; reward ideas that are implemented.
- **Financial**—Prioritize the allocation of resources among operations, maintenance, and capital improvements groups throughout WTD through uniform cost-benefit analyses, and identify a budget for completing optimization activities.

Identifying the Public and Environmental Health Benefits

For this CSO control program review, WTD took a fresh look at existing information, reviewed new information, and completed studies to assess—both quantitatively and qualitatively—the health benefits to the public, environment, and endangered species of completing the program. The assessment drew from studies describing existing environmental conditions and predicted conditions at the completion of the program. It built on the findings of the County’s 1998 *Water Quality Assessment of the Duwamish River and Elliott Bay* (WQA) and 1999 Sediment Management Plan—both done in support of the Regional Wastewater Services Plan (RWSP)—and on subsequent annual water quality reports. A summary of the information considered in this review follows.

CSO Water Quality Assessment—King County, 1998

The 1998 *Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay* (WQA) reviewed the health of the Duwamish River and Elliott Bay estuary and the effects of CSO discharges. A computer model was developed to predict existing and future water and sediment quality conditions, and a risk assessment was undertaken to identify risks to aquatic life, wildlife, and human health. Findings identified during the course the WQA were taken into account during development of the RWSP CSO control program.

The WQA found some risks to fish, wildlife, and humans from conditions in the estuary as it existed at the time, but predicted limited improvement if CSO discharges were eliminated from the estuary (Table 1).

The findings of the WQA helped determine the priority of the CSO projects in the RWSP. It was recommended that locations with the greater potential for human contact—the Puget Sound beaches—be controlled first. Locations in the Duwamish River were set later in the schedule on the basis of what was understood at the time to be a lower human health and environmental benefit from CSO control at these sites.

Some Chemicals Defined...

PCBs (polychlorinated biphenyls). Used in electrical equipment, paints, plastics, dyes, and other products, before being banned in the U.S in 1977. Known to cause cancer in animals and produce health effects in humans.

PAHs (polycyclic aromatic hydrocarbons). Byproducts of combustion of coal, oil, gas, wood, garbage, and tobacco, and in charboiled meat. May cause cancer, reproductive problems, birth defects, impaired immune function, and other health effects.

EDCs (endocrine disrupting chemicals). May be in natural or synthetic hormones, personal care products, industrial byproducts, plastics, and pesticides. Mimic, inhibit, or alter the hormonal regulation of the immune, reproductive, or nervous systems or other parts of the endocrine system.

TBT (tributyl tin). An EDC used in paints and as a pesticide. Is stable, persists in the environment, and is toxic to aquatic life.

Phthalates. Used in a variety of consumer products such as deodorant, nail polish, and perfume. Found to cause adverse health effects, including cancer, in laboratory animals.

Furans (and related dioxins). Byproducts of combustion, manufacture of herbicides, and bleaching of paper pulp. Found to cause adverse effects, including endocrine disruption, in laboratory animals. May cause cancer in humans.

Table 1. Water Quality Assessment Findings Regarding CSOs

Risk Target	Risk	CSO Control Benefit
Water column—dwelling aquatic organisms; salmon by direct or dietary exposure	None identified	No benefit
Sediment-dwelling organisms; salmon via dietary exposure	Potential risk from PCBs, TBT, bis(2-ethylhexyl) phthalate, mercury, PAHs; low risk from 1,4-dichlorobenzene	Slightly reduced risk ^a ; slight decrease in loadings of bis(2-ethylhexyl) phthalate, mercury, PAHs, and 1,4-dichlorobenzene
Wildlife	Low-to-high risks, depending on the species, from PCBs, lead, copper, and zinc	Slight decrease in loadings of lead, copper, and zinc
Humans – chemical exposures	Significant risk from exposure to arsenic and PCBs from fish consumption; potential risk from exposure to arsenic and PCBs when netfishing, swimming, windsurfing, and SCUBA diving	No benefit; the identified risk is not related to CSOs
Humans – pathogen exposures	Potential risk from fecal coliform, giardia, and viruses. People should avoid water contact during and for 48 hours after overflows.	Reduced risk; any benefit from reduced fecal coliform would not be apparent because inputs from other sources are so high

^a CSOs were not believed to be a significant source of PCBs or tributyl tin (TBT), but were considered a moderate source of 1,4 –dichlorobenzene.

Studies in Response to Endangered Species Act Listings—Various Entities, 1999–2005

In 1999, just before King County adopted the RWSP, the federal government listed Puget Sound Chinook salmon and bull trout as threatened under the Endangered Species Act. Just recently in 2006, killer whales were listed as endangered species.

Chinook salmon, also known as king salmon or blackmouth salmon, belong to the family Salmonidae and are one of eight species of Pacific salmonids in the genus *Oncorhynchus*. Chinook salmon are anadromous. That is, adults migrate from a marine environment into the freshwater streams and rivers of their birth to spawn (only once) and then die. Juvenile salmon feed and migrate in the shallow areas of rivers, streams, lakes, estuaries, and nearshore areas. They eventually migrate to the ocean, where, as adults, they will spend 3 to 4 years on average. Juveniles are present at different times in different water bodies, depending on life stage. Adult Chinook use the deep areas of the marine water bodies for foraging and the estuarine and freshwater areas for migration back to their spawning grounds.

Bull trout are members of the char subgroup of the salmon family. Some bull trout populations are migratory, spending portions of their lifecycle in larger rivers or lakes before returning to smaller streams to spawn. Others complete their entire lifecycle in the same stream. Some bull trout in the Coastal-Puget Sound population migrate between fresh water and the marine environment. Given the varied life history strategies of bull trout and the limited information

regarding the species (WDFW, 1998), the U.S. Fish and Wildlife Service (USFWS) assumes the presence of bull trout everywhere in their historical range unless proven otherwise. Bull trout are likely to occur in the same water bodies, except for Lake Washington, as outmigrating juvenile Chinook (which they prey on).

The decline of Chinook and other salmonid species has generally been attributed to four factors: habitat, hydropower, harvest, and hatcheries. Of the four factors, improvement of habitat quality would be the factor most closely linked with CSO. At the time of the listings, knowledge of the habitat needs, foraging areas, residence time, and other critical life stages of bull trout and Puget Sound Chinook was limited. Since the time of the listings, numerous organizations, both public and private, have worked to raise the collective level of knowledge and assess the needs of salmon. WTD has worked with the U.S. Army Corp of Engineers, USFWS, the City of Seattle, NOAA Fisheries, the tribes, and the Washington State Department of Fish and Wildlife (DFW) to increase our knowledge about Chinook and bull trout.

King County and City of Seattle CSO discharge points exist in the lower reaches of each of the two primary watersheds, called Water Resource Inventory Areas (WRIAs), in King County's wastewater service area: the Lake Washington/Cedar/Sammamish watershed (WRIA 8) and the Green/Duwamish and Central Puget Sound watershed (WRIA 9). Many of the questions that need to be answered for WRIA planning are identical to those that WTD must address in various projects, including CSO control. While the scientific needs of WRIA planning have been greater (for instance, in terms of geographic extent) than the specific needs of WTD, the success of WRIA planning will ensure a sound framework for the development of reasonable federal ESA requirements for the RWSP. Current watershed planning in response to the Chinook listing as threatened will support conservation of multiple species, including bull trout. King County supports the WRIA planning efforts that are addressing ESA issues within the County. Additional information about the WRIA planning efforts can be found in the King County *RWSP Annual Water Quality Report* and WRIA-related publications.

Presence of Threatened Salmon in King County Watersheds

The following sections describe the general characteristics of WRIAs 8 and 9, and present available information on the presence, abundance, and duration of threatened species within each watershed. Figure 1 shows the locations of the watersheds.

WRIA 8

The Lake Washington/Cedar/Sammamish watershed covers 692 square miles and contains two major river systems (Cedar and Sammamish), three large lakes (Washington, Sammamish, and Union), and numerous creeks including Issaquah and Bear Creeks. The basin drains into Puget Sound through the Ship Canal and Hiram Chittenden (Ballard) Locks. The WRIA includes the marine nearshore and a number of smaller creeks that drain directly to Puget Sound between West Point in the City of Seattle northward to Elliott Point in the City of Mukilteo in Snohomish County. WRIA 8 is the most densely populated watershed in Washington State, with approximately 1.3 million people in 2002 and an expected 1.6 million more people by 2022. King County CSOs along Lake Washington are controlled, but uncontrolled CSOs remain along the Ship Canal and nearshore areas near Carkeek Park.

Three Chinook populations inhabit the watershed: the Cedar River population, the North Lake Washington population, and the Issaquah population. The Cedar River population spawns in the Cedar River's main stem and to a lesser extent in its tributaries. When juveniles leave their river in the spring, they rear and migrate in shallow habitats along Lake Washington's shorelines, particularly in the south end. The North Lake Washington population spawns in the tributaries to northern Lake Washington and the Sammamish River, including Bear, Little Bear, North, and Kelsey Creeks. Issaquah Chinook spawn in Laughing Jacobs Creek. Propagation occurs through both natural spawning in the wild, and artificial spawning in the Issaquah hatchery. The three populations migrate in and out of the watershed through the lakes, Ship Canal, and Locks. Juveniles rear in the marine nearshore areas of Puget Sound before heading into the ocean. Assessments indicate that all three populations are at extremely high risk of extinction. The Cedar River population is at highest risk, followed by North Lake Washington and then Issaquah populations.²

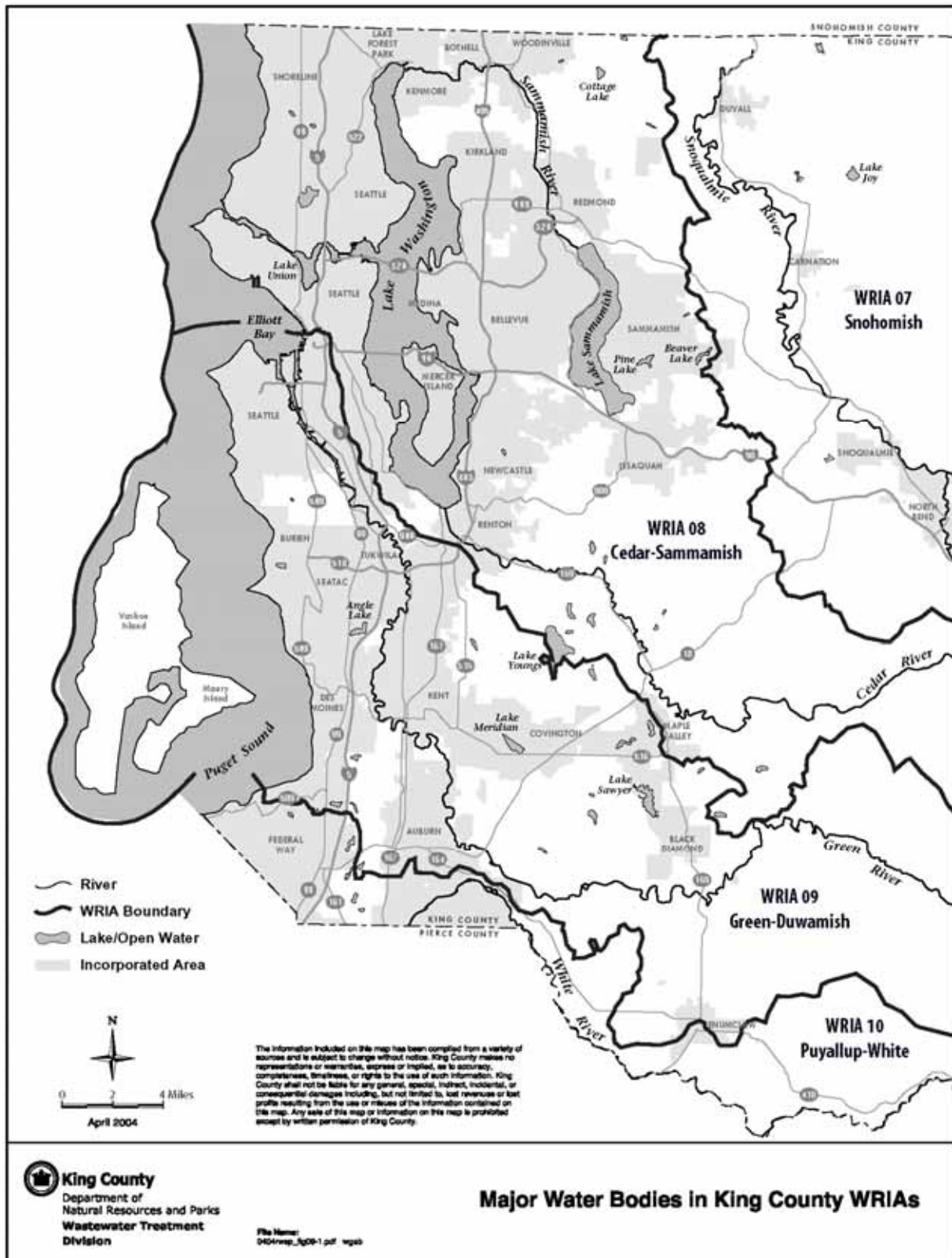
WRIA 9

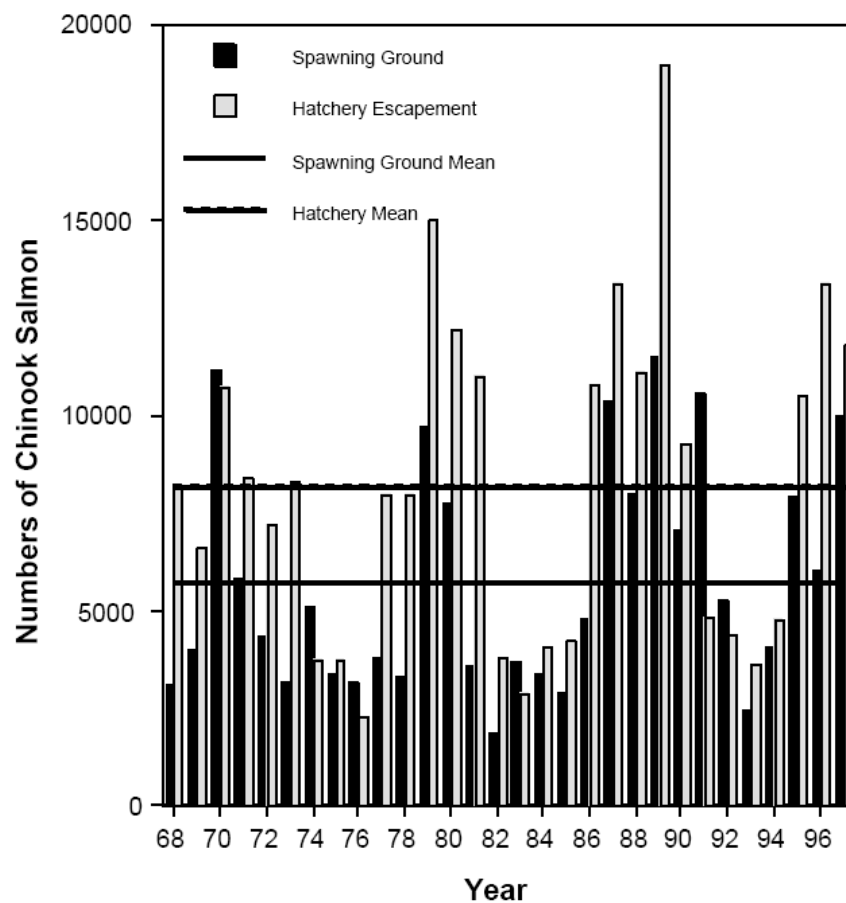
WRIA 9 is 568 square miles. Thirty percent of the WRIA is in the Urban Growth Area (UGA). In 1999, the population in WRIA 9 was estimated at 563,980 (adapted from PSRC data, 2000). About 89 percent of the population live in the UGA and 11 percent live in rural areas or resource lands. Two sub-watersheds are directly affected by CSOs: the Duwamish Estuary Sub-watershed and the Nearshore Sub-watershed. The Duwamish Estuary Sub-watershed is predominantly urban residential, commercial, and industrial. Nearly all the Nearshore Sub-watershed is urban residential. King County CSOs are located in the lower Duwamish River from the turning basin to the mouth, in Elliott Bay, and along the Alki shoreline.

The Green/Duwamish River system currently supports an average yearly total run (fish returning to the river and those caught in fisheries) of about 41,000 adult Chinook salmon. The run is divided into hatchery and naturally spawning populations. The naturally spawning component of the Chinook run contains a mixture of wild and stray hatchery Chinook. The percentage of the wild component is unknown. Wild run size has been higher during recent years (1983–1996) compared to earlier years (1968–1982), indicating that the downward trend common to other Puget Sound stocks is not evident among “wild” Green River Chinook salmon. Likewise, the Green River has not experienced the same decline in naturally spawning fish as has occurred in other streams in Puget Sound. The spawning goal has been met 6 of the last 10 years. The persistence of the naturally spawning component of the run is consistent with a high survival rate. Overall, Green River Chinook are resilient and have survived the effects of large-scale production of hatchery fish, high harvest rates, and habitat alteration. The spawning returns have been steady, though somewhat cyclical (Figure 2).³

² September 2002. *Salmon and Steelhead Limiting Factors Report for the Cedar Sammamish Basin (Water Resource Inventory Area 8)*.

³ December 2000, *WRIA 9 Habitat Limiting Factors and Reconnaissance Assessment for Salmon Habitat in the Green/Duwamish and Central Puget Sound Watershed*.





Time series of chinook salmon returning to the spawning grounds and to the hatcheries, 1968-1997. Spawning ground estimates include an unknown number of stray hatchery salmon. Mean values are shown. Data source: WDFW 1998.

Figure 2. Time Series of Green River Chinook Salmon Returning to the Spawning Grounds and to the Hatcheries, 1968-1997

Four different trajectories for juvenile Chinook are defined by the timing and size at which the fish reach the Duwamish estuary. The endpoint of each rearing trajectory is a juvenile that is ready to move offshore from near the river mouth into the greater Puget Sound estuary. The four trajectories are as follows:

- Emergent fry (1.6 to 1.8 inches) are uncommon in the estuary but may be present for months between March to late May, and in the Elliott Bay shoreline for several weeks to months between May and June.
- Fry/fingerlings (1.8 to 2.8 inches) are present in the estuary for several days to months between early April and late May, and in Elliott Bay for several weeks to months between May and June.
- Fingerlings (over 2.8 inches) are abundant in the estuary for several days to two weeks between late April and mid-June, and in Elliott Bay for several days to 2 weeks between May and June.
- Yearlings are uncommon and are seen only briefly in the estuary.

Watershed Planning—Various Entities, 2000–2005

In 2000, watershed planning activities began under precedent-setting interlocal agreements. These agreements involve cost sharing by more than 45 jurisdictions in support of the salmon conservation planning effort and provide for the creation of a new governance-management construct. In 2003 and continuing through 2005, the planning effort turned from assessments to development of Salmon Conservation Plans (also termed Habitat Plans).

Many of the questions that need to be answered for the WRIAs are identical to those that WTD must address in various projects, including CSO control. While the scientific needs of the WRIAs are greater (for instance, in terms of geographic extent) than the specific needs of WTD, the success of WRIA planning will ensure a sound framework for reasonable federal ESA requirements for the RWSP.

Salmon Conservation Plans have now been approved and published by the respective Forums (composed of local elected leaders representing the jurisdictions that have funded the planning effort)—WRIA 8 in July 2005 and WRIA 9 in August 2005. In 2005, the WRIA Forums addressed Salmon Conservation Plan implementation, the governance-management construct that they will develop, and the funding mechanisms necessary to implement the plans. In addition, negotiations with NOAA Fisheries and USFWS are occurring as the WRIA plans are rolled up into a regional recovery plan under the Shared Strategy for Puget Sound.

The Salmon Conservation Plans describe long-term habitat conservation and recovery actions in WRIAs 8 and 9 that take an ecological approach but concentrate on the needs of the ESA-listed species of Chinook salmon and bull trout. They include strategies, policies, and recommended projects to address the factors that limit salmon habitat in the watersheds that were identified earlier in reports published by the Washington Conservation Commission.⁴ Most habitat-limiting

⁴ December 2000. *Habitat Limiting Factors and Reconnaissance Assessment Report for the Green/Duwamish and Central Puget Sound Watersheds (Water Resource Inventory Area 9)*.

factors have occurred from development for human uses. The factors are similar for the lakes, rivers, and creeks, although the magnitude of impact varies by type of water body and specific watershed area. Moreover, the factors interact with one another to worsen the habitat problems seen in the aquatic systems. Factors shared by both watersheds include altered hydrology, habitat changes fostering increased predator populations, loss of floodplain connectivity, bulkheads in the marine nearshore that cut off much of the sediment supply to marine habitats, disrupted sediment processes, lack of riparian vegetation, loss of channel and shoreline complexity, barriers to fish passage, water withdrawals, and degraded water and sediment quality.

Both WRIA plans recommend actions in their lower reaches that should be considered in CSO planning. Both advocate that efforts be increased to protect sediment and water quality, especially near commercial and industrial areas where there is the potential for fuel spills, discharge of pollutants, and degraded stormwater quality. Because of the highly diluted nature of CSOs and the high level of uncertainty surrounding the effects of constituents found in CSOs on listed species, it is difficult to quantify any impact on bull trout or Chinook. While not a top concern to the WRIAs, there is the perception that CSO contributes to the degradation of water and sediment quality in salmon habitat. Associated with this perception is a larger concern about impacts from stormwater.

Habitat quality in the transitional areas of the estuaries is a priority. The WRIA 8 plan recommends the creation of pocket estuaries in the Ship Canal near the Locks in order to increase the estuary area transition zone, while the WRIA 9 plan recommends enlargement of the Duwamish estuarine transition zone habitat by expanding the shallow water and slow water areas. The WRIA 9 plan recommends that area projects be leveraged to create improved habitat. It specifically mentions sediment quality improvements through the Lower Duwamish Waterway Superfund cleanup. Other cleanup/control efforts and projects such as the Alaskan Way Viaduct and Seawall Replacement may be approached as opportunities to rehabilitate and create new shallow water beach habitat. Future CSO control projects will also likely be viewed as opportunities.

Habitat Conservation Planning—King County Wastewater Treatment Division, 1999–2005

The listing of bull trout and Chinook salmon as threatened under the ESA also prompted King County WTD to undertake the creation of a Habitat Conservation Plan (HCP) for all its activities that have any potential for “take.” Take under ESA means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct [ESA §3(19)]. Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. An HCP is a long-term voluntary agreement that usually contains an adaptive management provision outlining plans for dealing with uncertainties over the life of the agreement.

September 2002. *Salmon and Steelhead Limiting Factors Report for the Cedar Sammamish Basin (Water Resource Inventory Area 8)*.

HCP Process and Decisions

The HCP was proposed as a voluntary, two-phased, 40-year agreement with NOAA Fisheries and USFWS (the Services) that outlined WTD's efforts to protect threatened and endangered species, while carrying on its wastewater management activities. Phase I covered operational wastewater discharges from the South and West Point Treatment Plants and construction and maintenance of gravity sewers, force mains, pump stations, and storage facilities. The Brightwater System, which was included in the original HCP scope, was removed to pursue independent permitting for the project. The scope of Phase II included analysis of CSOs. WTD representatives produced several in-depth technical papers and worked toward negotiated agreements that would provide the framework for the HCP.

In April 2005, after completion of Phase I and after meetings with Services managers, the HCP effort was stopped. The WTD activities contained in the Phase I analyses included adequate avoidance and minimization measures, and any potential remaining impacts could not be quantified because of the uncertainty of effects on listed species. Because the uncertainties were so large, the commitment of resources required to match the uncertainty level was substantial. WTD felt that the long-term expense did not justify the uncertain risk and chose to seek individual ESA Section 7 consultations for projects with a federal link.

Results of HCP Studies on Bioaccumulating Chemicals

While it is relatively simple to identify areas of potential take from construction activities such as land clearing or laying pipe and then to use methods to avoid or minimize impacts, it is more difficult to understand potential sub-lethal effects on salmon from the discharge of treated effluent. Discharges from WTD's secondary treatment plants occur deep in Puget Sound. CSOs occur during periods of heavy rains, resulting in a highly dilute discharge. The potential effects on salmon of constituents contained in these discharges will depend on both length of time of the exposure, bioaccumulation (if any) in prey species, and the relative toxicity and concentration levels of the constituent.⁵

As part of the process to develop an HCP, WTD reviewed available information to assess the potential for King County secondary treatment plant effluent discharges to contribute to any bioaccumulation of persistent bioaccumulative toxins (PBTs) and endocrine disrupting chemicals (EDCs). This information does not directly apply to CSOs because secondary treatment will remove many chemicals that were in the wastewater. However, the study does provide information that was reviewed for any applicability. The risks resulting from CSOs appear to be low because the chemical concentrations in CSOs are low and exposure is brief and infrequent. Studies will continue until definitive answers are known and regulations instituted. Findings are discussed in more detail in the following sections.

Persistent Bioaccumulative Toxins

WTD assessed 33 chemicals that are found in effluent and identified on lists of PBTs developed by state, federal, and international agencies. The 33 PBTs were classified based on whether

⁵ In bioaccumulation, low concentrations of chemicals build up in the food web to levels resulting in tissue concentrations that are harmful to aquatic organisms or to those that prey on them, including humans.

available data suggested they might be bioaccumulating and to whether King County's discharges might be a significant source relative to other sources. Twelve PBTs appear to be bioaccumulating in the Puget Sound food web. These PBTs, grouped by category are as follows: pesticides (alpha/gamma chlordane, DDD, DDE, DDT, and dieldrin); PCBs (total PCBs, Arochlor 1242, Arochlor 1248, Arochlor 1254, and Arochlor 1260); dioxins (PCDDs), and furans (PCDF). Compared to other sources, it does not appear that WTD secondary effluents are significant contributors of these chemicals. Most appear to come from diffuse sources or are no longer being produced, but persist and may move between environmental media, for example from air to stormwater, or from groundwater infiltrating into sewers. Although they have not been detected in CSOs, the chemicals may be present in levels below detection limits.

Mercury also appears to be bioaccumulating in the Puget Sound food web. Mercury has been found in sediment near County outfalls, and in influent, secondary effluent, reclaimed water, biosolids, and CSOs. Not enough data are available to determine if County effluents and CSOs are significant contributors relative to others. In any event, the County has identified common sources of mercury and adopted specific rules to limit mercury discharges by area dentists, the greatest known source of mercury, into its collection system.

Assessment results were published in April 2002 as *Bioaccumulation and King County Secondary Treated Effluent: Data Review, Method Evaluation, and Potential for Impacts on Puget Sound Aquatic Life*.

Endocrine-Disrupting Chemicals

Endocrine glands produce hormones that regulate metabolic processes. Chemicals that are endocrine disruptors mimic, inhibit, or alter this hormonal regulation of systems, such as the immune, reproductive, or nervous system or other parts of the endocrine system. Many potential endocrine disruptors are chemicals common in the environment because people use them in every aspect of their lives. Some endocrine-disrupting chemicals (EDCs) may be in natural or synthetic hormones, personal care products like soaps and cosmetics, industrial byproducts, plastics, and pesticides. This area of study is so new that scientists are still discovering what groups of chemicals are EDCs. Studies will continue for many years before definitive answers are known and regulations instituted.

As part of the HCP process, current scientific literature on endocrine disruptors was reviewed, including their presence in wastewater effluents and their effects on aquatic species.⁶ The review concluded that there is inadequate knowledge of which chemicals exert endocrine disrupting effects, the biological and ecological significance of these effects, and their mechanistic bases. The evidence points to natural and synthetic estrogenic hormones (for example, from birth control medications) as responsible for the greatest estrogenic exposure from wastewaters. These hormones occur in wastewater effluents at concentrations, albeit very low (ng/L), that have been shown to elicit possible endocrine mediated effects. Other chemicals found in wastewater (such as phthalates and alkylphenolic compounds) may have weaker estrogenic effects.

⁶ January 2002, *Literature Review of Endocrine Disruptors in Secondary Treated Effluent: Toxicological Effects in Aquatic Organisms*.

There is evidence linking exposure to EDCs with effects on aquatic organisms. EDCs in combined sewage typically are diluted by a 9:1 ratio, and any exposure to aquatic organisms would be expected to be very small and infrequent. The nature and severity of the effects are still being explored. King County will continue to follow the science as it emerges.

Possible Exposure of Chinook Salmon to CSOs—King County WTD Studies Conducted for the 2005 CSO Program Review

As part of this CSO program review, an assessment of the presence and abundance of chinook salmon in comparison with average exposure to CSOs was done. The previous 5 years of discharge frequencies and volumes were combined by water body, graphed, and then superimposed on a graph showing the presence and relative abundance of chinook by month. Graphs prepared for the Duwamish River and the Ship Canal are shown in Figure 3 and Figure 4 as examples of the graphs that were prepared. In general, the majority of juvenile chinook salmon are present during periods of the fewest discharges and the smallest volumes; however, every water body had at least one discharge during every month that fish were present.

Juvenile chinook salmon are present in all water bodies for most of the year and have a greater sensitivity and vulnerability than adult chinook to alterations in the nearshore habitats from CSO structures and discharges. However, because the exposure of juveniles to CSOs is infrequent and because chemicals in CSOs are diluted through mixing, it was concluded that CSO discharges present little measurable harm to juvenile Chinook. Additionally, because the essence of an ESA-based evaluation is a comparison between existing and future conditions, implementation of the CSO reduction plan will show a consistent improvement in habitat quality over time.

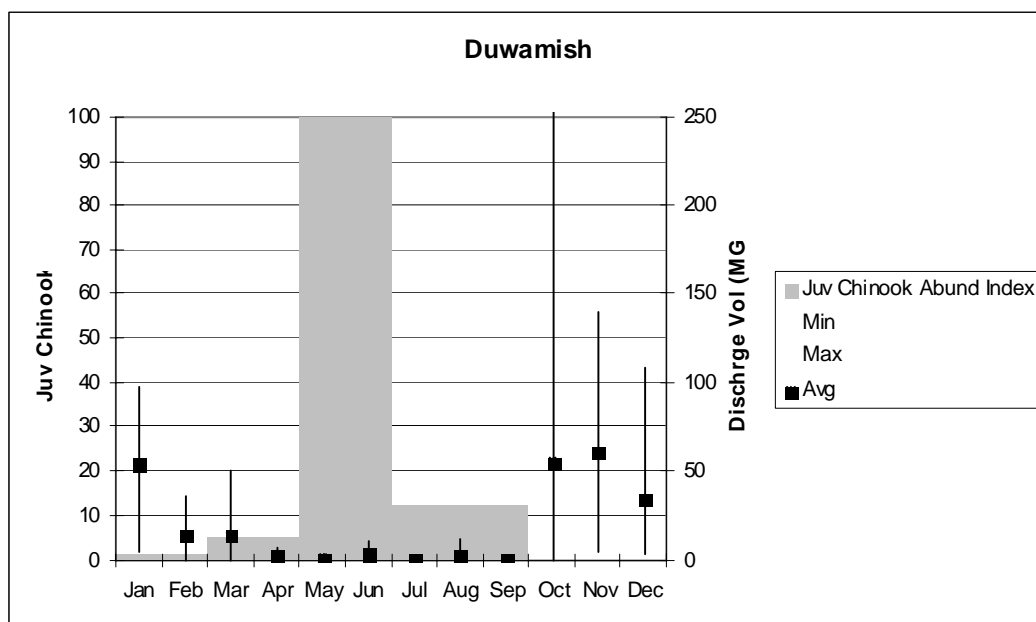


Figure 3. Presence of Duwamish River Chinook During CSO Discharge—Monthly Average Volume, 1999-2004

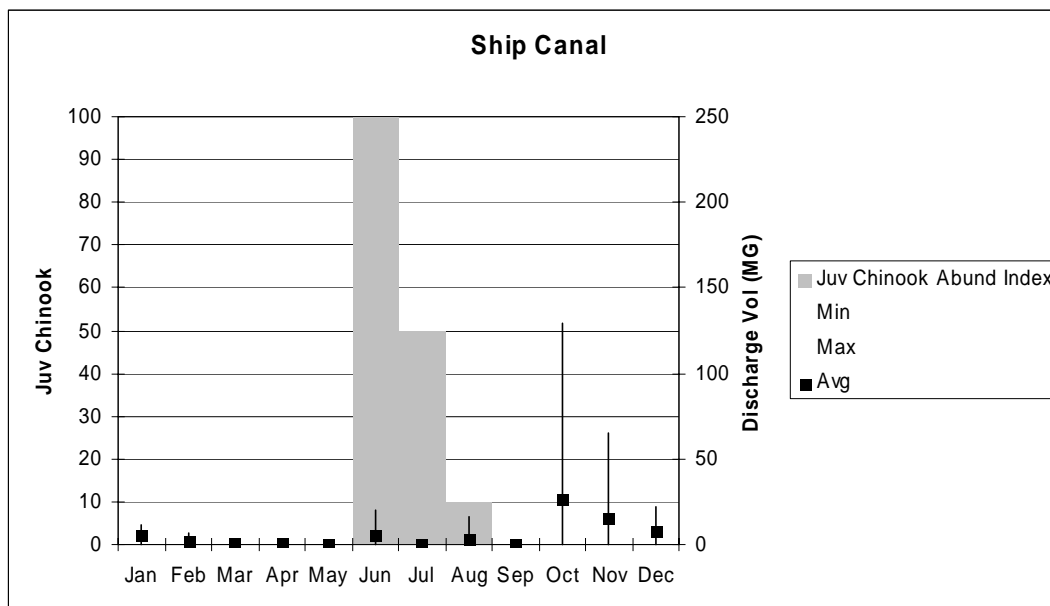


Figure 4. Presence of Ship Canal Chinook During CSO Discharge—Monthly Average Volume, 1999-2004

Sediment Management Activities—King County WTD and Others, 1999–2005

The RWSP had recognized management of contaminated sediments as important and so had called for the development of a sediment management plan. At the time of the 2000 CSO control plan update, the RWSP sediment management plan (SMP) had been recently completed. It highlighted the growing interest in sediment management as a factor in CSO control planning and the need for more information about CSOs as a current or historical contributor to contamination. The sediment management program was formed to implement the SMP and to implement any new projects developed after the SMP within the broader context of wastewater planning. The program addresses sediment quality issues near CSO discharges and treatment plant outfalls, evaluates and addresses emerging wastewater treatment sediment quality issues, and incorporates sediment quality considerations into comprehensive planning.

Projects Recommended in the SMP

The SMP assessed areas near seven County CSOs that were listed on the Washington State Contaminated Sites list for their risk, preferred cleanup approach, partnering opportunities, and potential for recontamination after remediation (Table 2). The remediation schedule for these areas, shown in Table 2, is being implemented.

Table 2. Recommended Projects in the Sediment Management Plan

Nearby CSO and Water Body	Cleanup Priority	Recommended Cleanup Approach	Partnering Opportunity	Cost (million \$) ^a	Scheduled to be Completed
Duwamish/ Diagonal ^b (Duwamish River)	High	Dredging and capping	King County under direction of EBD RP ^c	8.90 ^d	Completed 2004
King Street (Puget Sound, Elliott Bay)	High	Capping	WSDOT and Seattle	2.60	2008
Hanford (Duwamish River)	Medium/High	Dredging and confined aquatic disposal (CAD)	Port of Seattle	15.49	2007
Lander (Duwamish River)	Medium/High	With Hanford	U.S. Army Corps of Engineers	3.45	2007
Denny A & B ^e (Puget Sound)	Medium	Dredging and capping		2.23	2006
Denny C & D (Puget Sound)	Medium	Capping		0.90	2009
Chelan Ave. (Puget Sound, Elliott Bay)	Low/Medium	Dredging and CAD		2.80	2010
Brandon St. (Duwamish River)	Low	Capping		0.50	2012

a. These costs are given in 2005 dollars (the original estimates, given in 1998 dollars, escalated by 3 percent per year).

b. This project was added after the SMP.

c. These costs were not included in the SMP; it was assumed that they would be paid by the Elliott Bay/Duwamish Restoration Program (EBDRP).

d. EBD RP administers projects funded under a 1990 settlement of litigation by the National Oceanic and Atmospheric Administration (NOAA) for natural resource damages from City of Seattle and King County CSOs and storm drains.

e. This is a City of Seattle storm drain; King County's Hanford No. 1 CSO uses this outfall.

King County CSOs as Part of Duwamish Superfund Sites

Since completion of the SMP, the Harbor Island Superfund site was extended across the East Waterway of the Duwamish River to include the Port of Seattle's dredging project near the County's Lander and Hanford CSOs. Discussions are occurring with the Port of Seattle and EPA regarding whether King County should participate in the current East Waterway Superfund process and incorporate the remediations near the Hanford and Lander CSO sites into the larger response.

Also since preparation of the SMP, the Lower Duwamish Waterway (LDW) was listed as a federal Superfund site. In December 2000, King County, the Port of Seattle, the City of Seattle, and Boeing entered into an Administrative Order on Consent with EPA and Ecology. Because of their early involvement in the process before the site was listed under Superfund, the agreement gives the County, City, and Port unprecedented access and participation in the initial remedial investigation and feasibility study (RI/FS).

Phase 1 of the RI is completed. The purpose of Phase 1 was to examine existing data on the risks to human health and the environment from sediment-associated chemicals in the LDW, to identify early action remediation candidates, and to focus the scope the Phase 2 investigation.

Although they do not relate directly to CSO control, the Phase 1 studies do represent state-of-the-art knowledge about aspects of environmental and human health related to the Duwamish River where many County CSOs occur.

Phase 2 is currently under way and is estimated to be completed in 2007. Phase 2 will fill the data gaps identified in Phase 1, will assess risks to human health and the environment prior to early action remediations, and will estimate risks, including any risks associated with CSOs, that remain after completion of early remedial actions.

Results of Phase 1 Remedial Investigation for the Lower Duwamish Waterway

The Phase 1 RI did not identify specific sources of pollution, but did recognize the general categories of historical land use and disposal practices, industrial or municipal releases of wastewater or stormwater, spills or leaks, atmospheric deposition, and waste disposal on land or in landfills. The general impression given in the RI is that chemicals currently found in the sediments result from historical practices over many years.

The Phase 1 RI risk assessment evaluated risks to both the environment and to human health. The environmental risk assessment covered crabs, English sole, juvenile Chinook salmon, bull trout, great blue heron, spotted sandpiper, bald eagle, river otter, and harbor seal. The assessment also examined benthic invertebrate and rooted aquatic plant communities and evaluated studies on effects to juvenile Chinook salmon. While these studies showed increased exposure to chemicals such as PCBs, PAHs, and DDT relative to reference sites, there was not enough evidence to conclude that adverse effects resulted from this exposure. Contaminants of potential concern were identified, preliminary risk estimates for each of the species was done, and recommendations for Phase 2 evaluations were made. For juvenile Chinook salmon, bull trout, and English sole, the following chemicals were estimated to pose low risk: mercury, DDT, and PCBs for salmon; copper for bull trout; and DDT for English sole. The study recommended that Phase 2 further evaluate PCBs, TBTs, PAHs, arsenic, and mercury and collect additional copper and DDT exposure data for these species.⁷

The Phase 1 human health risk assessment identified ways that people could be exposed to chemicals found in LDW sediments, the potential extent of such exposures, and the groupings into exposure scenarios. Direct contact with sediments from commercial netfishing, beach play, and consumption of resident seafood were identified as the three primary exposure scenarios. Forty-three contaminants of potential concern were identified for at least one of these three exposure scenarios. Because of many uncertainties, the human health risks identified in the assessment did not constitute a definitive characterization.

Carcinogenic and noncarcinogenic human health effects were evaluated separately. Estimated lifetime excess cancer risk in the LDW was found to be highest for the seafood consumption scenario, with the cumulative risk for all carcinogenic chemicals estimated at 2 in 1,000 for the tribal resident seafood consumption. The primary contributors were arsenic, carcinogenic PAHs,

⁷ Recommendations for benthic invertebrates, wildlife, and rooted aquatic plants can be found in the Phase 1 RI report.

and PCBs. The cancer risk from netfishing and beach play was much lower but included some risk from dioxins and furans. The assessment identified some potential for other adverse effects associated with seafood consumption, primarily based on arsenic, PCBs, TBT, and mercury.

The risk estimates were high enough to support moving forward with early action remediations, rather than waiting for Phase 2 results. Seven sites were identified for early action remediation. Two of the sites were near King County CSOs: Norfolk and Diagonal/Duwamish. Sediment near the Norfolk site had already been remediated in 1999; remediation of the Diagonal/Duwamish sediment was completed in 2004 by King County, the City of Seattle, and the Elliott Bay/Duwamish Restoration Program (EBDRP).⁸ Early actions at sites not associated with CSOs are being implemented by other LDW members.

These RI studies are not complete and conclusions are not firm, but they point in directions that the CSO control program will need to consider in the future. Although fish exposure projections do not warrant alteration of the CSO control plan at this time, emerging information will need to be followed closely. Recent EPA guidance for the Phase 2 human health risk assessment requires the use of fish consumption studies developed by local tribes. The much higher consumption rates will increase the identified risks to human health. Very preliminary Phase 2 results also suggest that current human health sediment quality targets may not be adequately protective and may need to be reviewed. While there is no direct link to CSOs as a cause at this time, the increased attention and concern may influence control and schedule decisions.

Post-Remediation Monitoring at the Diagonal/Duwamish and Norfolk Sites

Fifteen-year follow-up sampling of the Diagonal/Duwamish and Norfolk site remediations was built into the remediation plans for these sites because predictions regarding recontamination could not be made with any confidence. The value of early removal of as much of the contamination by the worst pollutants was considered worth the risk of the occurrence of lesser recontamination.

Five years of monitoring at the Norfolk site has been completed. No recontamination was seen. One sample in the last year showed unexpected contamination, which warrants further examination. So far, the contamination cannot be linked to ongoing CSO or stormwater discharges. The CSO was controlled after the last sampling event.

One year of monitoring at the Diagonal/Duwamish site has been completed. PCB concentrations are approaching the Sediment Quality Standards (SQS) in the cleanup area. However, continued discharges are not expected to significantly increase PCBs in the future because samples taken of sediments in sewer and stormwater pipes that discharge to the area contain comparable levels of PCBs to those found in the cap. PAHs have increased in the cap, but not above SQS when normalized to their organic carbon content. Source control efforts tend to be successful for petroleum products, and several sources have already been controlled. As with PCBs,

⁸ The Elliott Bay/Duwamish Restoration Program administered projects funded under a 1990 settlement of litigation by the National Oceanic and Atmospheric Administration (NOAA) for natural resource damages from Seattle and County CSOs and storm drains.

concentrations of PAHs in source samples are comparable to those in the cap; therefore, cap concentrations are not expected to continue to increase.

Phthalates, however, have increased in the cap significantly since the remediation. Phthalates are believed to come from a variety of sources, perhaps in low levels that add up across many inputs, such as stormwater (via vehicular traffic), wastewater (via everyday products), and air deposition. They are very difficult to control. If the trend cannot be reversed, concentrations in the cap could reach pre-cleanup levels. Phthalates probably accumulate in sediments across the nation. The problem is being highlighted here because Washington State has sediment management standards. The problem will likely not be solved by changes in the CSO control schedule. Phthalate removal efficiency will be included in the pilot tests of promising CSO treatment technologies that will begin in 2006. Considerable discussion is occurring on this topic, and progress will be reported in the 2008 CSO plan update and 2010 CSO program review.

Climate Change and Sea Level Rise

On October 27, 2005, King County Executive Ron Sims called together experts from across the country in a conference called “The Future Ain’t What it Used to Be—Preparing for Climate Disruption.” The purpose of the conference was to discuss the latest information on global warming and climate change and to begin a conversation on their implications to providers of public services in the Pacific Northwest.

Despite differing opinions on the details and climate models, there is broad scientific consensus that climate change is occurring as a result of human actions, especially the creation of greenhouse gases by burning fossil fuels, and that steps need to be taken to both prepare for the expected affects of climate change and to possibly prevent them from worsening.

Over the twentieth century, the Pacific Northwest has grown warmer and wetter. The average trend in temperature is an increase of 1.4°F since 1950 (an increase of 1.1°F globally), with nearly equal warming in summer and winter. Annual precipitation has also increased nearly everywhere in the region, by 11 percent on average. The greatest increases (about 50 percent) have occurred in northeastern Washington and southwestern Montana.

Regional warming is expected to continue at an increased rate in the twenty-first century. Average increases in warming over the region are projected to reach about 3°F by the 2020s and 5°F by the 2050s. These increases are well outside the natural range of climate in the twentieth century. This rise cannot be turned back because the forces causing it have been set in motion in ocean conditions that respond slowly. Without global intervention, by the 2090s, average summer temperatures are projected to rise by 7.3°F to 8.3°F, while winter temperatures will rise 8.5°F to 10.6°F.

Projections about future general precipitation changes are less certain, ranging from a small decrease (7 percent) to a slightly larger increase (13 percent) through 2050. These changes are within the range of year-to-year variability that has been experienced over the past 100 years in the Pacific Northwest. However, nearly all the climate models show larger seasonal trends of wetter winters with more intense rainfall; projected increases in winter (October–March)

precipitation range up to 20 percent by mid-century. Changes in April–September precipitation are uncertain, while a decrease in June–August precipitation is considered possible.

These factors combined lead to the following general implications:

- Lower-elevation rivers that are fed mostly by rain may see increased wintertime flow.
- Warmer temperatures may result in less winter precipitation that will fall as snow, the snow elevation will rise and there will be less snowpack for later melting and use.
- Spring and snowmelt will occur earlier in the year (already 2 weeks early in parts of the Puget Sound region).
- Rivers that derive some flow from snowmelt will see increased winter flow, earlier peak flow, and reduced summer flow.
- Warmer summers, warmer water temperatures, and lower summer streamflow may result in increased mortality rates for juvenile salmon in streams.

Sea-level rise is another important impact of climate change. Melting of the polar caps, increased river flow, and disruption of climate patterns such as the El Niño will raise sea level and increase the severity of storms and storm surge in parts of the Northwest coast. Low-lying areas are already at risk from projected average sea-level rise and are at even greater risk from average sea-level rise combined with storm waves, accelerated erosion at the base of bluffs and along the coast, and shrinking wetlands.

Compounding sea-level rise resulting from climate change are geological forces related to the uplift or subsidence (sinking) of the land surface as tectonic plates converge (move toward or under one another). Extending from northern California to British Columbia, the Juan de Fuca Plate is being pushed underneath, or subducted by, the North American Plate at a rate of 1.6 to 2 inches per year. In the Pacific Northwest, there are basically two regions of uplifting land, one centered at the mouth of the Strait of Juan de Fuca, rising at 0.1 inch per year, and the other at the mouth of the Columbia River, rising by 0.06 inch per year. On the Washington coast, uplift may offset some of the sea-level rise caused by climate change. The southern portion of Puget Sound, on the other hand, is sinking at up to 0.08 inch per year, or about an inch every 12 years. As a result of this subsidence, risks of sea-level rise are greatest in southern Puget Sound. A rise of 12 to 32 inches over a 75-year period is projected for Puget Sound. (Global sea level is expected to be 19 inches higher by 2100, with a range of 6 to 37 inches).

Potential implications of this information to CSO planning are as follows:

- Increased risk of river flooding and undermining of nearby sewer pipes and facilities
- Increased infiltration into pipes, resulting from higher water tables
- Increased possibility of inflow of river and estuary water into the combined sewer system at outfalls
- Increased inflow into sanitary and combined sewers from impaired drainage of stormwater systems
- Increased pumping to overcome sea-level rise
- Larger pump stations and storage facilities to accommodate increased combined sewer flows resulting from precipitation shifts from snow to rain, with more intense peaks

WTD will monitor developments in the understanding of climate change and sea-level rise. The design of new CSO control facilities or of modifications to existing facilities will consider climate impacts and sea-level change anticipated during the life of the facility. Possible accommodations could include increased sizing, higher facility elevations with respect to nearby water bodies, increased pumping, and enhanced flood and storm surge protections. Decisions as to when to implement these design features will be made based on when it would be most cost-effective to do so while still meeting the need.

Analyzing Rate Impacts

Updated RWSP Cost Estimates

Table 3. RWSP CSO Control Projects

CSO Location	RWSP Project Description	Dates	RWSP Capital Cost (million, 1998\$)	RWSP Capital Cost (million, 2005\$)
Alaska	0.7 MG storage	2005-2010	\$4.28	(\$5.26, but not needed)
S. Magnolia	1.3 MG storage tank	2005-2010	\$6.76	\$8.31
Murray	0.8 MG storage tank	2005-2010	\$5.06	\$6.23
Barton	Pump Station upgrade	2006-2011	\$9.34	\$11.49
North Beach	Storage/pump station expansion	2006-2011	\$3.94	\$4.84
University/Montlake	7.5 MG storage	2009-2015	\$53.53	\$65.83
Hanford #2	3.3 MG storage/treatment tank	2012-2017	\$27.91	\$34.33
West Point Modifications	Build secondary clarifiers for CSO	2013-2018	\$16.90	\$20.78
Lander	1.5 MG storage, treatment at Hanford	2014-2019	\$26.00	\$31.98
Brandon	0.8 MG storage/treatment	2017-2022	\$13.06	\$16.06
Michigan	2.2 MG storage/treatment tank	2017-2022	\$32.41	\$39.86
Chelan	4 MG storage	2019-2024	\$18.35	\$22.57
Kingdome (Connecticut)	2.8 MG storage/treatment tank	2021-2026	\$31.85	\$39.17
Hanford @ Rainier	0.6 MG storage	2021-2026	\$3.26	\$4.01
King	Conveyance to Connecticut	2021-2026	\$3.15	\$3.87
Terminal 115	0.5 MG storage	2022-2027	\$3.94	\$4.85
West Michigan	Conveyance expansion	2022-2027	\$0.39	\$0.48
8 th Ave S	1 MG storage	2022-2027	\$6.87	\$8.45
3 rd Ave W	5.5 MG storage	2024-2029	\$28.34	\$34.85
Ballard	1 MG storage (40% King Co.)	2024-2029	\$2.93	\$3.60
11 th Ave NW	2 MG storage	2025-2030	\$12.94	\$15.91
CSO Plan Updates	Mandated, but not funded	2000, 2005	\$0	\$5.30 added ¹
Total Program Cost			\$311.21^{2, 3}	\$382.77

¹ Costs for future program reviews and plan updates are not included.

² RWSP CSO budget of \$360 million (98\$) included \$48.77 million for Denny and Henderson, but the projects were accelerated and removed from the RWSP project list

³ The 2004 RWSP Update reported a total program cost of \$366 million. Corrections identified since would have identified the program cost as \$360 million, both values in 2003\$

Cost Control—CSO Treatment Technology Review

Solids Treatment Technologies

The following solids removal methods were reviewed and compared to the performance of conventional primary treatment:

- chemically enhanced (polymer-only),
- settling and chemically enhanced (lamellar plate and polymer-only combination), and
- ballasted sedimentation/flocculation.

A key design criteria for solids removal is Surface Overflow Rate (SOR). This is the volume of wastewater treated per square foot of treatment facility (gallons per day per square foot, or gpd/ft²). Typically, the higher the SOR, the lower the performance of any solids removal process because the flow passes through the process faster than some of the solids can settle. The SOR relates directly to the footprint or size of a facility. As long as a technology achieves treatment goals, higher SORs will result in smaller size facilities. The size of the facility relates directly to the cost of the facility. Roughly speaking, the higher the SOR, the more flow that can be managed per square foot of facility and per dollar.

While a great amount of theoretical information is available on alternatives to conventional solids removal technologies, actual performance information for CSO applications was quite limited. To compensate, data from stormwater treatment and wet-weather split-flow treatment at secondary plants were also considered. The data sources are summarized in the following pages. The data should be interpreted keeping in mind the differences between stormwater and CSOs—specifically the higher organic material content of CSOs that may be more difficult to remove with primary treatment methods and the higher bacteria counts and the higher proportion of bacteria from human sources. Performance of solids removal technologies taken from the literature reviews is shown in Figure 5. The area below each line in the figure indicates the SORs at which near 100 percent TSS removal is achieved. The top of each line indicates 0 percent TSS removal.

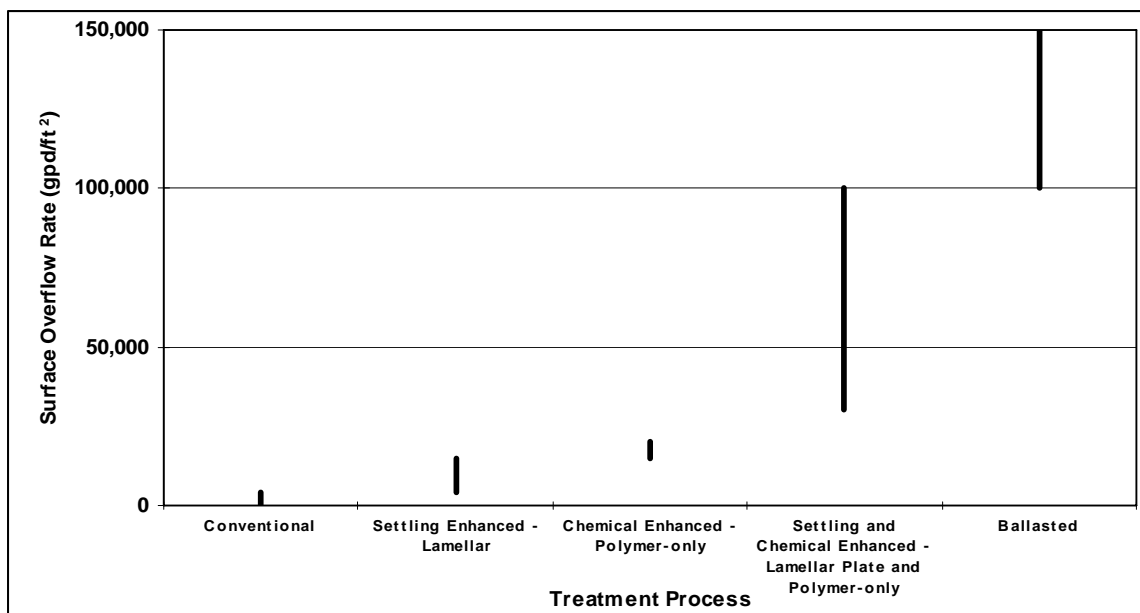


Figure 5. Relative Performance of Solids Removal Technologies

In a technology review workshop convened by King County, panel members from consulting firms with experience in CSO treatment rated the different technologies according to criteria considered important to County staff during earlier meetings (Table 4). Conventional primary treatment technologies were rated highest in the more important criteria. Ballasted sedimentation was rated low in those criteria, but rated higher in flexibility and footprint.

Table 4. Ranked Selection Criteria

Criteria	Importance
Reliability	Very important
Simplicity of operation	Very important
Treatment performance flexibility	Important
Size/footprint	Important

At the second workshop, the general costs of the technologies were compared. The results, from lowest to highest cost, are listed in Table 5.

Table 5. Cost of Solids Removal Technologies

Lowest Cost → Highest Cost			
High SOR ballasted (SOR = 100,000 gpd/ft ²)	conventional primary with polymer addition (SOR = 20,000 gpd/ft ²)	conventional primary (SOR = 4,000 gpd/ft ²)	low SOR ballasted (SOR = 20,000 gpd/ft ²) (as assessed in the 2000 CSO plan update)

Disinfection Technologies

Four disinfection technologies were compared to conventional disinfection with hypochlorite: chlorine dioxide, bromine, ozone, and ultraviolet (UV). Studies of high-rate chlorination were also reviewed.

Relative effectiveness was rated, in ascending order of effectiveness (Table 6). Even though it ranked lowest in effectiveness, conventional disinfection ranked high. Bromine and UV had mixed results. Conventional disinfection, therefore, remained the technology of choice, with some interest in bromine and UV. Ozone was not recommended for further consideration.

Table 6. Relative Effectiveness of Disinfection Technologies

Lowest Effectiveness				Highest Effectiveness
Conventional chlorination with hypochlorite	Bromine disinfection	Chlorine dioxide	UV	High-rate chlorination with hypochlorite

Disinfection with chlorine traditionally relies on low doses of chlorine, with long contact times to achieve bacteria kill. Studies of high-rate chlorination showed that contact times on the order of 5 minutes and chlorine doses on the order of 10 mg/L can provide significant reductions in fecal coliform, as long as sufficient mixing energy is provided. Similar to the earlier SOR discussion, contact time relates directly to facility size and cost. Lower contact times can result in smaller facilities and lower cost. Issues to be considered are formation of disinfection byproducts, reaction or bonding (“complexation”) with ammonia, loss of potency while stored (which would be more significant for intermittent CSO treatment than typical wastewater treatment) and material handling safety.

Assessing Public Opinion—CSO WQA Stakeholder Committee

The stakeholder process for King County’s 1998 *Water Quality Assessment of the Duwamish River and Elliott Bay* (WQA) provided CSO-specific public opinion to the RWSP. The Stakeholder Committee was appointed to provide oversight and input to ensure that the CSO WQA would reflect the values of our diverse community. Members included advocates of environmental, business, tribal, and neighborhood interests, agency representatives, technical specialists, and laypeople. Members of the Stakeholder Committee were as follows:

David Bortz, Washington State Department of Natural Resources
Elliott Berkihiser, The Boeing Company
Gerald Brown, Ash Grove Cement
Patrick Cagney, U.S. Army Corps of Engineers
Patricia Cirone, EPA Region 10
B.J. Cummings, Puget Soundkeeper Alliance
Charles Cunniff, Environmental Coalition of South Seattle
Allan Davis, Duwamish Valley Neighborhood Preservation Coalition
Lorna Dove, Georgetown Crime Prevention & Community Council
Margaret Duncan, Suquamish Tribe
Kevin Fitzpatrick, Washington State Department of Ecology
John Glynn, Washington State Department of Ecology
Bruce Harpham, Rainier Audubon Society
Patrick Hawkins, King County Regional Water Quality Committee
Doug Hotchkiss, Port of Seattle
Larry Kirchner, Seattle-King County Department of Public Health
Kathy Minsch, Puget Sound Water Quality Action Team
David Moore, Sierra Club
Mark Myers, National Marine Fisheries Service
Tim O’Brian, Duwamish Valley Neighborhood Preservation Coalition
Sandra O’Neil, Washington State Department of Fish & Wildlife
Bill Robinson, Trout Unlimited
Ruth Sechena, University of Washington, Department of Environmental Health
Gary Shirley, Metropolitan Water Pollution Abatement Advisory Committee
Chantal Stevens, Muckleshoot Tribe
Greg Wingard, Waste Action Project